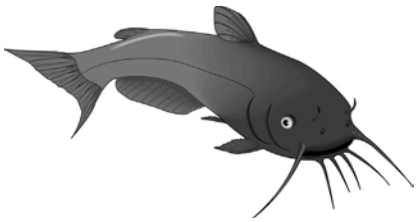
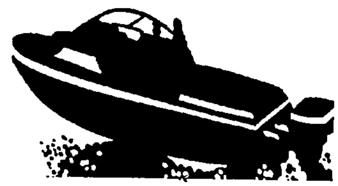
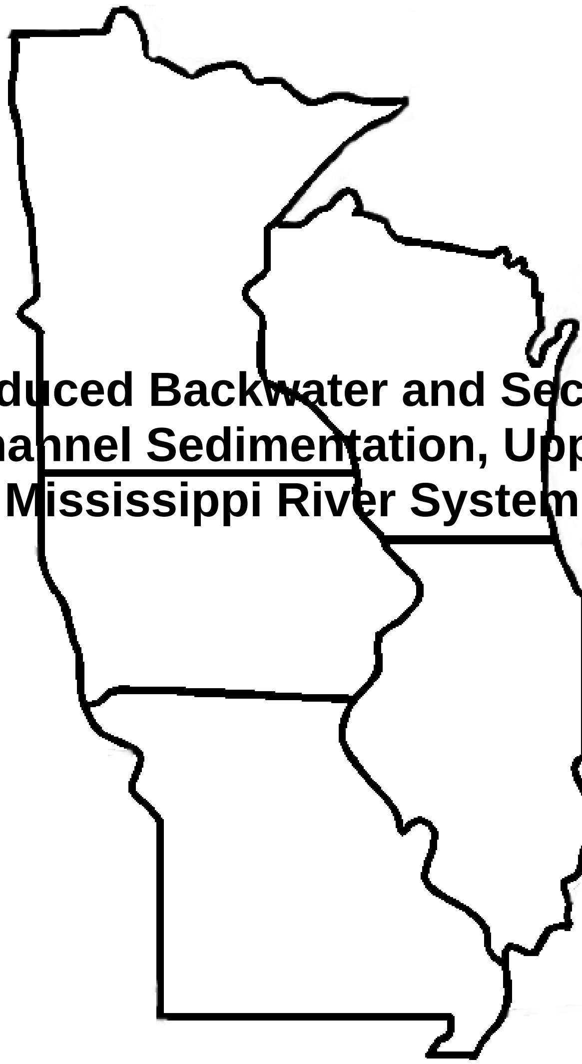
ENV Report 41

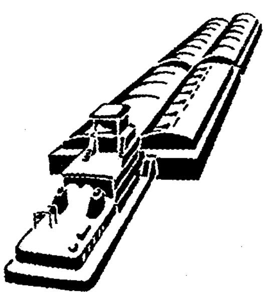
Interim Report For The Upper Mississippi River – Illinois Waterway System Navigation Study







Tow-Induced Backwater and Secondary Channel Sedimentation, Upper Mississippi River System



August 2003

Rock Island District
St. Louis District
St. Paul District

US Army Corps of Engineers

Upper Mississippi River - Illinois Waterway System Navigation Study

ENV Report 41
August 2003

Tow-Induced Backwater and Secondary Channel Sedimentation, Upper Mississippi River System

Thomas J. Pokrefke, Jr., R. Charlie Berger, Joon P. Rhee, Stephen T. Maynord

Coastal and Hydraulics Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Interim report

Prepared for U.S. Army Engineer District, Rock Island
Rock Island, IL 61204-2004
U.S. Army Engineer District, St. Louis
St. Louis, MO 63103-2833
U.S. Army Engineer District, St. Paul
St. Paul, MN 55101-1638

ABSTRACT: The work reported herein was conducted as part of the Upper Mississippi River – Illinois Waterway (UMR-IWW) System Navigation Study. The information generated for this interim effort will be considered as part of the plan formulation process for the System Navigation Study.

The UMR-IWW System Navigation Study is being conducted by the U.S. Army Engineer Districts, Rock Island, St. Louis, and St. Paul, under the authority of Section 216 of the Flood Control Act of 1970. Commercial navigation traffic is increasing and, in consideration of existing system lock constraints, will result in traffic delays that will continue to grow into the future. The System Navigation Study scope is to examine the feasibility of navigation improvements to the Upper Mississippi River and Illinois Waterway to reduce delays to commercial navigation traffic. The study will determine the location and appropriate sequencing of potential navigation improvements on the system, prioritizing the improvements for the 50-year planning horizon from the year 2000 to 2050. The final product of the System Navigation Study is a Feasibility Report, including the decision documents for processing to Congress.

One of the concerns possibly associated with potential improvement plans is the determination of sediments introduced to backwaters and secondary channels from towboat navigation. Specifically, the volume of sediments entering backwaters and secondary channels in Mississippi River trend pools (Pools 4, 8, 13, and 26), in the open-river trend reach (River Miles 31 to 74), and in the LaGrange Pool on the Illinois Waterway needed to be quantified. After that was accomplished, linkages were to be developed to take the quantified impacts from the trend pools (reach) where significant data are available to the nontrend pools where data were less intensive. These linkages provide extrapolated impacts to the nontrend pools and information to be used to evaluate system impacts and potential mitigation guidance where necessary. The part of the study reported herein determined only how much sediment is delivered to the backwaters and secondary channels of the specified inlets, and computations and resulting sedimentation quantities are the result only of towboat navigation resuspending the channel bed material. As this study effort progressed, it was determined that computing the delivery rates and potential for impacts for base and alternative conditions provided a logical approach for use in addressing backwater and secondary channel sedimentation trends as a result of towboat navigation.

Contents

List of Tables

Preface

The work reported herein was conducted as part of the Upper Mississippi River–Illinois Waterway (UMR–IWW) System Navigation Study. The information generated for this interim effort will be considered as part of the plan formulation process for the System Navigation Study.

The UMR–IWW System Navigation Study is being conducted by the U.S. Army Engineer Districts, Rock Island, St. Louis, and St. Paul, under the authority of Section 216 of the Flood Control Act of 1970. Commercial navigation traffic is increasing, and in consideration of existing system lock constraints, will result in traffic delays, which will continue to grow in the future. The system navigation study scope is to examine the feasibility of navigation improvements to the Upper Mississippi River and Illinois Waterway to reduce delays to commercial navigation traffic. The study will determine the location and appropriate sequencing of potential navigation improvements on the system, prioritizing the improvements for the 50-year planning horizon from 2000 through 2050. The final product of the System Navigation Study is a Feasibility Report, which is the decision document for processing to Congress.

This study was conducted in the Coastal and Hydraulics Laboratory (CHL), Vicksburg, MS, of the U.S. Army Engineer Research and Development Center (ERDC). The work was conducted during the period of October 1997 to July 2000 under the direction of Dr. J. R. Houston, past Director of CHL, and Mr. T. W. Richardson, Director of CHL.

This report was edited and published by the Information Technology Laboratory, ERDC. Mr. Robert C. Gunkel, Jr., Environmental Laboratory (EL), ERDC, was responsible for coordinating the necessary activities leading to publication. Dr. Elizabeth C. Fleming was Acting Director, EL, ERDC.

The analysis to determine tow-induced backwater and secondary channel sedimentation was performed by Mr. Thomas J. Pokrefke, Jr., Acting Deputy Director, CHL. Drs. R. Charlie Berger, Estuarine Engineering Branch, CHL; and Joon P. Rhee, Operations and Analysis Group, Coastal Engineering Branch, CHL, conducted the research and prepared Appendix A. Dr. Stephen T. Maynord, Navigation Branch, CHL, and Mr. Pokrefke performed and prepared the study methodology comparison presented in Appendix B; and Mr. Pokrefke performed the analysis presented in Appendix C. Dr. Rose M. Kress and Mr. Scott Bourne, Environmental Systems Branch, Ecosystem Evaluation and Engineering Division, EL, provided technical assistance relative to providing

UMR–IWW database information and presentation of results. Numerous staff members from the Rock Island, St. Louis, and St. Paul Districts and various state and Federal resource agencies also provided technical guidance throughout the development and application of sedimentation to UMR–IWW backwaters and secondary channels.

This report received independent technical reviews by Dr. David Soong, U.S. Geological Survey, Illinois District; Mr. Patrick M. Foley, U.S. Army Engineer District, St. Paul; Mr. Marvin R. Martens, U.S. Army Engineer District, Rock Island; and Mr. Kevin J. Landwehr, U.S. Army Engineer District, Rock Island.

COL James R. Rowan, EN, was Commander and Executive Director of ERDC. Dr. James R. Houston was Director.

1 Introduction

Background

One aspect of the Upper Mississippi River–Illinois Waterway (UMR–IWW) System Navigation Study (UMRS) under investigation in the Coastal and Hydraulics Laboratory (CHL) and the Environmental Laboratory (EL), Vicksburg, MS, U.S. Army Engineer Research and Development Center (ERDC), is the determination of sediments introduced to backwaters and secondary channels from towboat navigation. Specifically, CHL and EL were tasked with quantifying the volume of sediments entering backwaters and secondary channels in Mississippi River trend pools (Pools 4, 8, 13, and 26), in the open-river trend reach (River Miles 31 to 74), and in the LaGrange Pool on the Illinois Waterway. Linkages were to be developed to take the quantified impacts from the trend pools (reach), where significant data are available, to the nontrend pools where data were less intensive. These linkages provide extrapolated impacts to the nontrend pools and information to be used to evaluate system impacts and potential mitigation guidance where necessary.

Initially all of the backwaters and secondary channels within the UMRS area were classified. A Hydraulic Classification of Aquatic Areas was conducted to help make the linkages from the trend pools to the nontrend pools. This classification included separation of backwaters into contiguous (flow through), single-opening, impounded (the areas generally immediately upstream of the navigation dams), and isolated backwaters. Numerous characteristics of these backwaters were developed, such as length, width, area, water area, number of inlets, number of outlets, and number of through channels. Secondary channels were attributed with information such as reach length, valley length, sinuosity, width, surface area, diversion angle, distance to inlet, number of islands, and wingdams. Additionally, the types of sediment adjacent to the backwaters and secondary channels were linked to these areas. It was projected that trend pool backwaters and secondary channels and those in nontrend pools would be linked using similar backwater type (i.e., single inlet, single through channel, and single outlet), water area, and adjacent sediment type (Parchure, McAnally, and Teeter 2000). An analysis (Nickles and Pokrefke 2000) of the Hydraulic Classification established these linkages. However, as the quantification of the trend pool backwaters and secondary channels progressed, it was determined that a better linkage could be used to accomplish that task. This report describes that method and the results.

Methodology

As the various modeling efforts progressed and were finalized, it was determined that in the trend pools, the volume of sediment delivered to backwaters or secondary channels could be calculated as the result of resuspension of channel bed materials from towboats. It was also determined that sufficient data were available in the nontrend pools to accomplish some computations necessary to provide a better linkage than would be realized by just using the Hydraulic Classification. Using the NAVEFF (Maynord 1996, 1999) program developed for the UMRS, towboat impacts in the main channel can be determined. This includes propeller jet effects, generation of return currents from the towboat, drawdown along the channel border areas, and waves from the tow. The NAVSED (Copeland et al. 2001) program takes output from the NAVEFF program and computes resuspension of the designated channel bed material due to the velocity changes created by the return currents, propeller jets, and towboat-induced waves. For the backwater and secondary channel sedimentation, specific NAVEFF cells are identified and associated with specific inlets, and the computations are conducted for 108 tow configurations, 3 flow conditions (low, medium, and high within each pool), and 3 sailing channel locations (90 percent on the middle sailing line and 5 percent at the left and right sailing channel limits). The 108 tow configurations were various combinations of push boats, number of barges, loaded or unloaded, direction of travel, and push boat attribute (Kort nozzle or open propeller) historically operating on the Mississippi River and Illinois Waterway. The output from the NAVSED program is then fed into the BACKSED program (Appendix A), which computes the volume of sediment resuspended per tow at each identified inlet cell for each month. Those volumes then go into a statistical method (also used for the UMRS biological models) that rolls up the probabilities associated with tow configurations, flows, and sailing line to identify various probability levels of sediment delivered to the backwater or secondary channel. The value used in the backwater and secondary channel sedimentation has been based on the median or 50 percent rollup value. This value was used since it represented a reasonable mix of various tow configurations and normal, overall impacts. Appendix B of this report addresses the impacts on the study results due to using a median versus an average rollup value. Figure 1 is a flowchart of the procedure followed using the various programs and methods to obtain sediment volumes in backwaters and secondary channels.

Once the annual volume of sediment was obtained for a specific NAVEFF cell, that volume was used to compute impacts over the entire backwater or secondary channel. It was realized that in situations where noncohesive sediments were introduced into an inlet channel, the material might deposit at the confluence of the inlet channel and backwater. This is a very local condition and one that required much more detailed modeling than could be undertaken in a systemwide type study. Therefore, the formation of deltas of noncohesive sediments in the actual backwater or secondary channel was not addressed in this study.

It should be noted that this study determined only how much sediment is delivered to the specified inlets. It is believed that some or all of those sediments

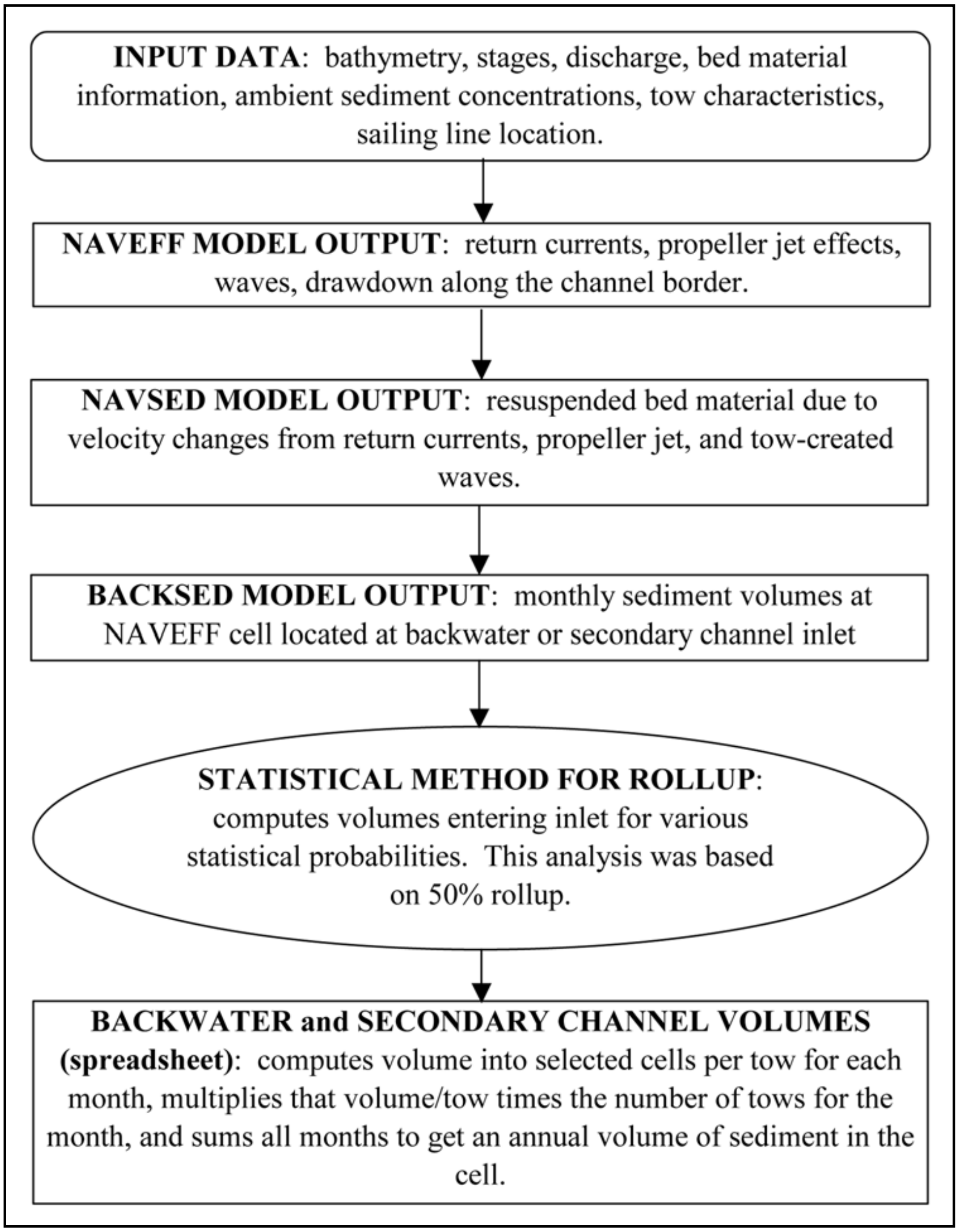


Figure 1. Flowchart of procedures and models used for computing sediment volumes

may simply pass through the area, or may settle out to be possibly resuspended and removed from the backwater or secondary channel during annual high-flow events. This issue will be discussed further when the results are presented. Also, the computations and resulting sedimentation quantities are the result of only towboat navigation resuspending the channel bed material. No computations include the sediments passing into backwaters or secondary channels strictly as a result of the flow and ambient or background sediments entering that area. This would be the sediment that "naturally" moves into such areas.

Also, sediment quantities carried into these areas during flood events, or the impacts of wind, wind-generated waves, or recreational vessel generated sediment loads were not included in the computations.

The methodology described was applied to all of the Mississippi River trend pools. One necessary input parameter available for the trend pools, but not for the nontrend pools, is the discharge into the inlet. For the trend pools those values for the low, medium, and high flows were obtained by conducting two-dimensional numerical model studies using the TABS-2 model. This information was needed for computations conducted in the BACKSED program. The discharge into the backwater or secondary channel was required since the sediment being carried by the inflow would be added to the sediment entering the inlet due to drawdown of the water surface by towboat passage.

As the computations and methods were developed for the backwater and secondary channel sedimentation, it was determined that the resuspended sediment concentrations computed in the NAVSED program were too high compared to observed field data. The field data used for that comparison were the data collected by the Illinois State Water Survey (Bhowmik et al. 1996) and ERDC (Fagerburg and Pratt 1998). A review of the NAVSED code was conducted, and it was determined that the exponents used in the erosion rate equation for the waves needed to be modified. Different exponents were necessary for soft, cohesive and medium, cohesive sediments. With this revision, the output from the NAVSED wave algorithm reproduced the observed data to a more reasonable degree. This revision was made to the code, and the results reported herein reflect that revision.

During the review of the Hydraulic Classification, some members of the UMRS Navigation Environmental Coordination Committee (NECC) were concerned with the methodology used by CHL to delineate backwaters and secondary channels. The concern was related to the aquatic area delineations used by the various agencies in managing their resources. In certain locations there was the perception that an attribute was classified as a contiguous backwater in the Hydraulic Classification, and the resource agencies considered it to be a secondary channel. Going through the sedimentation computations using NAVEFF and NAVSED provides channel and channel border information to use in the BACKSED program. The BACKSED program treats any backwater that has flow through it (i.e. an inlet, at least one through channel, and an outlet) identically to a secondary channel. However, single-opening backwaters are treated differently, since for any stage condition, there is no flow from the main channel into the backwater. Therefore, the BACKSED program considers that for the backwaters and secondary channels with flow through them, the sediment concentrations at the inlets are increased due to tow traffic. As the volume of water drawn out of a backwater or secondary channel due to drawdown from the towboat enters the inlet, the increased sediment concentration is applied to the water replacing the volume removed plus the normal flow into the inlet. On a single-opening backwater with no through flow, only the volume of water drawn out due to the drawdown from the towboat introduces sediments into the backwater. As the water surface stabilizes and the volume of water removed from the backwater flows back into it, the water that flows into the backwater may have concentrations greater than ambient.

Level of Significance

Initial computations for volumes of sedimentation into backwaters and secondary channels were presented based on tons per year. Those results were presented to the UMRS Model Integration Simulation Team (MIST) and the NECC using that format. At the July 1999 NECC meeting, the resource agencies requested that tons/year and years to fill specific backwaters or secondary channels be changed to acre-ft/year and rate of sediment delivery in cm/year, respectively.

During the Great River Environmental Action Team (GREAT) study Simons et al. (1981) estimated that backwaters and secondary channels in Pools 4 through 10 were filling at a rate of 0.08 ft/year (1 in./year or 2.5 cm/year). Contacts were made with the U.S. Army Engineer Districts, St. Louis and Rock Island, the U.S. Army Engineer Division, Mississippi Valley, and ERDC personnel relative to the accuracy of hydrographic surveys. All contacted indicated that a typical hydrographic survey is accurate to "within plus or minus one-half foot" or "within one foot." Therefore, using the rates indicated by Simons et al. (1981) it would take 6 to 12 years until the backwater or secondary channel filling could be detected using typical hydrographic survey techniques.

In September 1999, a team of CHL researchers and a representative of the Rock Island District participated in a workshop to address extrapolation from the trend pools to the nontrend pools for backwaters and secondary channels. Table 1 presents the criteria, or significance established for various delivery rates for this study. These criteria were based on computations, as well as Simons et al. (1981) estimates.

Table 1
Level of Significance Based on Delivery Rates

Delivery Rate cm/year	Impact Color	Impact Potential
< 0.1	BLUE	Negligible
> 0.1 and < 1.0	YELLOW	Medium
> 1.0	RED	High

These delivery rates were a function of the measured area of a specific backwater or secondary channel. The BLUE delivery rate indicates very small amounts of sediments being introduced into the backwater or secondary channel. If all of the material was retained in the particular backwater or secondary channel, that is, the delivery rate became the actual filling rate, it would take 300 years or more to accumulate 1 ft (0.3 m) of sediment. The YELLOW delivery rate would take 30 to 300 years to accumulate 1 ft (0.3 m) of sediment. The RED delivery rate indicates an area, assuming all sediment delivered was retained, that could accumulate 1 ft (0.3 m) of sediment in 30 years or less. The workshop participants decided that these levels of significance were reasonable and helpful in delineating backwaters or secondary channels that, as a minimum, have the potential for being impacted by towboat navigation. It should be noted that the long-term issue of sediment compaction was not taken into account for this method of determining significance. Using these levels of significance would provide the U.S. Army Corps of Engineers (the Corps) with sites that may be candidates for future monitoring.

Other criteria were set based on the volume, rather than the rate, of sediments introduced into a backwater or secondary channel inlet. The level of significance set for annual volumes was 1.0 acre-ft/year (1,233.49 cu m/year) or greater. This value was used to designate backwaters or secondary channels as having a medium (YELLOW) potential for impacts. The criterion was based on individual inlets receiving that volume of sediments, and not a function of the entire backwater or secondary channel area or a sum of all inlets. Therefore, in areas with multiple inlets, if at least one inlet has a volume input of 1.0 acre-ft/year (1,233.49 cu m/year), the entire area is designated as YELLOW. With non-cohesive sediments (specific weight of 96.3 lb/cu ft (1,542.6 kg/cu m)), 1.0 acre-ft (1,233.49 cu m) equals approximately 2,100 tons (1.9×10^6 kg); with cohesive sediments (specific weight of 78.0 lb/cu ft (1,249.4 kg/cu m), 1.0 acre-ft (1,233.49 cu m) equals approximately 1,700 tons (1.5×10^6 kg). These values are consistent with results presented initially to NECC. These volumes were determined to be of sufficient magnitude to be used as a reasonable indicator for potential impacts.

The level of significance was based on these two quantifiable values for sediment entering inlets to backwaters and secondary channels. Those values included sediment volume and rate of sedimentation. However, as the analysis proceeded, a third quantifiable value, the volume of sediment per unit channel width, was also used (see the section, "Extrapolation to Mississippi River nontrend pools" in Chapter 2). These values were used as the basis in the extrapolation process from the trend pools to the nontrend pools. A summary of the various levels of potential impacts discussed in the preceding paragraphs is presented in Table 2.

Table 2
Levels of Significance

	Impact Potential		
Criterion	**Negligible (BLUE)**	**Medium (YELLOW)**	**High (RED)**
By volume	<1.0 acre-ft/year (1,233 cu m/year)	≥1.0 acre-ft/year (1,233 cu m/year)	No criteria
By rate	<0.1 cm/year	≥0.1 cm/year and <1.0 cm/year	≥1.0 cm/year
By unit volume	<0.01 acre-ft/year/m (12.33 cu m/year)	≥0.01 acre-ft/year/m (12.33 cu m/year)	No criteria

At the inception of this portion of the study it was proposed that the increase in sedimentation due to the incremental increase in towboat traffic from base condition to various alternatives was going to be the measure of impacts. As this study effort progressed, it was determined that computing the delivery rates and potential for impacts as described for base and alternative conditions provided a logical approach. Then if a particular backwater or secondary channel had an increase in impact potential due to alternatives, that is, went from BLUE to YELLOW or YELLOW to RED, the incremental impact would be addressed.

Computation of Sediments into Backwaters and Secondary Channels

As discussed in the “Level of Significance” section, the potential for impacts was based on determining either the volume of material entering an inlet, the rate at which a backwater or secondary channel would fill from all inlets, or the volume of sediment entering any particular inlet per unit channel width. This section will present the methodology for obtaining those quantities.

The volume of material entering any of the inlets to a backwater or the inlet to a secondary channel was obtained using the 50 percent rollup value of sediment resuspended in the NAVEFF cell adjacent to each inlet. The value obtained was the volume of sediment that would enter the inlet for each tow that passed the inlet. That value was obtained for all twelve months of the year. The twelve monthly values were inserted into a spreadsheet and then multiplied by the number of tows (based on the particular traffic alternative) in that pool for each month. The monthly volume was summed for the entire year, giving the annual sediment delivered from each NAVEFF cell into each inlet. The annual sediment entering each inlet was converted to units of acre-feet/year based on the specific weight of the bed material associated with that particular NAVEFF cell. If the material was classified as cohesive, a specific weight of 78.0 lb/cu ft (1,249.4 kg/cu m) was used in the conversion. If the material associated with the NAVEFF cell was classified as noncohesive, a specific weight of 96.3 lb/cu ft (1,542.6 kg/cu m) was used. These specific weights were used for all pools and open river reaches of the Mississippi River and for the Illinois Waterway.

The rate at which the volume of sediment was entering an entire backwater or secondary channel was computed by summing the volume for all of the inlets to a backwater and dividing that volume into the total area of the backwater covered by water. For secondary channels the volume entering the inlet was divided into the area of the secondary channel covered by water. The units of the results were then converted to centimeters/year at the request of NECC.

It should be noted that the specific values computed in this analysis are not necessarily the absolute values or the exact volumes or rates of sediment entering backwaters or secondary channels. The computed values are better compared against other backwaters or secondary channels. This analysis addresses the potential for impacts from towboat navigation. Therefore, the analysis and associated computations are based on a reasonable representation of the flow hydraulics (three flow conditions) and documented ambient sedimentation concentrations. The tows operating are based on a statistical distribution of the 108 documented configurations. The sediment resuspended is based on the specific bed material in the area, the impact of the energy produced by the tow and its propeller on the bed, and the waves created by the tow in the channel border areas. The volume of sediment introduced into an inlet is based on the amount of water-surface drawdown at the inlet and the volume of water normally entering the inlet. The ranges of input parameters and subsequent outputs have the potential for a wide degree of variability. Therefore, using the computations as a qualitative determination of impact potential provides a measure of the backwaters or secondary channels that most likely will be subjected to changes if the towboat traffic changes.

Proposed Alternatives

The Rock Island District provided the proposed alternatives and associated traffic projections for this study. The alternatives presented for the Mississippi River trend pools are based on the navigation traffic projections for six of the proposed alternatives in the planning study being considered by the Corps. Two traffic scenarios for the without-project condition, for year 2000 and year 2050, are also presented. The traffic projections for the year 2050 were used for the alternatives considered. On the LaGrange Pool the without-project scenario for year 2000 and year 2050 and six alternatives for the year 2050 are presented. In the open-river reach, two without-project traffic scenarios and six alternatives for the year 2050 are presented. Table 3 presents the specific alternatives and description of proposed improvements for the pooled portion of the Mississippi River, the Illinois Waterway, and the open-river portion of the Mississippi River.

Table 3
Proposed Alternatives

Alternative	Description
B	Mooring Cells at L&D 12, 18, 20, 22, & 24 Guidewalls at L&D 20 through 25
E	Mooring Cells at L&D 12, 18, 20, 22, & 24 Guidewalls at L&D 14 through 18 Replacement Locks at L&D 20 through 25
F	Mooring Cells at L&D 12, 18, 20, 22, & 24 Guidewalls at L&D 14 through 18 and LaGrange & Peoria Locks Replacement Locks at L&D 20 through 25
J	Mooring Cells at L&D 12, 18, 20, 22, & 24 Guidewalls at L&D 14 through 18 Replacement Locks at L&D 20 through 25 Additional Locks at LaGrange & Peoria
K	Mooring Cells at L&D 12, 18, 20, 22, & 24 Replacement Locks at L&D 14 through 18 Replacement Locks at L&D 20 through 25 Additional Locks at LaGrange & Peoria
L	Mooring Cells at L&D 12, 18, 20, 22, & 24 Replacement Locks at L&D 14 through 18 Replacement Locks at L&D 20 through 25

2 Presentation of Results

This chapter presents the results of the computations for the trend pools (or reach). For continuity and clarity the portions of the UMRS are presented separately. The trend pools (or reach) for the particular portion of the study area are presented, followed by the nontrend pools (reaches) for that portion. For this effort, the UMRS was divided into three reaches: the pooled portion of the UMR, the Illinois Waterway, and the open-river portion of the UMR. The four Mississippi River trend pools (Pools 4, 8, 13, and 26) are discussed first, then the nontrend pools (the remainder of Pools 1 through 26). The pools in the Illinois Waterway are presented next with LaGrange Pool being the only Illinois Waterway trend pool. Finally, the open-river reach, covering River Miles 0.0 to 203, is presented. In that portion of the river, the reach from River Miles 31 to 74 is the trend reach for the open river.

It should be noted that the tables have some entries of 0.0000 or 0.00000. These values may be a truncation (numerical rounding) or actually zero depending on the specific NAVEFF cell being used. Regardless whether the number presented is truncated or actually zero, the sediment load or rate at which that sediment is delivered is so low that negligible sediment would enter the backwater or secondary channel through such an inlet. Also, in the plates presenting the results, only the backwaters and secondary channels that had a medium or high potential for impacts were documented.

Mississippi River Pools

Results in trend pools

The methodology and levels of significance described in Chapter 1 were used to address the four trend pools on the Mississippi River. Each trend pool will be discussed separately.

Pool 4. The results of the computations for sediment delivered to Pool 4 backwaters are presented in Table 4. Multiple entries in column 1 of Table 4 for some backwaters (BW3, BW9, and BW10) indicate that the backwater has more than one inlet. The BACKSED program computes sediment at the cell adjacent to each of these inlets, and the volumes are accumulated to obtain the total for each backwater. In those backwaters with multiple inlets, the first row presents the water area used to determine the summed sediment delivery (presented in column 5) for the backwater. As can be seen in Table 4, the traffic scenarios

TABLE 4. SEDIMENTS TO BACKWATERS, MISSISSIPPI RIVER POOL 4

BASED ON 50% ROLLUP

			WITHOUT PROJECT						ALTERNATIVE B			ALTERNATIVES E, F, and J			ALTERNATIVES K and L		
			YEAR 2000 -1,322 TOWS			YEAR 2050 - 1,236 TOWS			YEAR 2050 - 1,421 TOWS			YEAR 2050 -1,722 TOWS			YEAR 2050 - 1,905 TOWS		
BW Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
BW1	83	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW2	67	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW3	1345	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW3			0.0000			0.0000			0.0000			0.0000			0.0000		
BW3			0.0000			0.0000			0.0000			0.0000			0.0000		
BW4	178	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW5	31	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW6	71	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW8	145	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW9	2676	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW9			0.0000			0.0000			0.0000			0.0000			0.0000		
BW9			0.0000			0.0000			0.0000			0.0000			0.0000		
BW9			0.0000			0.0000			0.0000			0.0000			0.0000		
BW10	102	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW10			0.0000			0.0000			0.0000			0.0000			0.0000		
BW12	859	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE

Note: To convert acres to square meters, multiply by 4,046.873. To convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] BW7 not included due to presence of tributary. BW11 not included because it is created by a railroad embankment and is adjacent to impounded backwater.

without project for the years 2000 and 2050 indicated negligible impacts and were given an impact color of BLUE. For Alternatives B, E, F, J, K, and L, even with an increase in towboat traffic at the year 2050 compared to without project, the impacts based on sediment delivered to the backwaters remained negligible. Therefore, all backwaters remained BLUE for these alternatives. During the Hydraulic Classification no secondary channels were delineated; therefore, those attributes were not addressed in Pool 4.

Pool 8. The results of the computations for sediment delivered to Pool 8 backwaters are presented in Table 5 and to Pool 8 secondary channels in Table 6. As shown in Table 5, all backwaters are BLUE for all conditions except BW2. The without-project value for the year 2000 for BW2 has a sediment load into the backwater of 2.68 acre-ft/year (3,305.75 cu m/year) (for the first inlet) and a sediment delivery rate of 0.13 cm/year. These values increase to 3.91 acre-ft/year (4,822.94 cu m/year) and 0.19 cm/year in the year 2050 for Alternatives K and L, the highest projected traffic level. Therefore, BW2 was given an impact color of YELLOW. Plate 1 depicts a portion of Pool 8 from the UMRS Geographic Information System (GIS) database and shows the limits of BW2, its location relative to the channel mile markers, and other backwaters that are BLUE. All of the secondary channels in Pool 8, except SEC8, had negligible sediment delivered to them and have impact color BLUE. Secondary channel SEC8 was YELLOW (Plate 2) for the traffic projected with Alternatives K and L with a value of 0.10 cm/year, which just met the established level of significance (0.1 cm/year).

Pool 13. The results of the computations for sediment delivered to Pool 13 backwaters are presented in Table 7 and to Pool 13 secondary channels in Table 8. Computations indicate that all backwaters are BLUE with the exception of BW11, which is YELLOW for without-project and all alternatives. In this case the last two inlets had annual loads greater than 1.0 acre-ft/year (1,233.49 cu m/year) and sediment delivery rates greater than 0.1 cm/year, but less than 1.0 cm/year. This backwater is presented in Plate 3 with other backwaters in the area presented for reference. It should be noted that BW8 was not included in the computations because it is part of a game refuge with a levee type structure around it. The Pool 13 secondary channel results indicated that 10 of the channels would have negligible impacts and were colored BLUE for all conditions. Two secondary channels, SEC8 and SEC12, were YELLOW for the year 2000 without-project traffic scenario. Both secondary channels remained at that level of significance for all alternatives. The annual sediment delivery for SEC8 varied from 0.12 cm/year (year 2000, without project) to a high of 0.18 cm/year (year 2050, Alternatives K and L). For SEC12 the annual delivery varied from 0.26 cm/year (year 2000, without project) to a high of 0.39 cm/year (year 2050, Alternatives K and L). Plate 4 shows the location of SEC8, and Plate 5 shows the location of SEC12 in Pool 13.

Pool 26. The results of the computations for sediment delivered to Pool 26 backwaters and secondary channels are presented in Tables 9 and 10, respectively. It should be noted that Pool 26 is divided into two sections at the confluence of the Mississippi River and the Illinois Waterway. This separation was necessary since the towboat traffic level on the Mississippi River downstream of

TABLE 5. SEDIMENTS TO BACKWATERS, MISSISSIPPI RIVER POOL 8

BASED ON 50% ROLLUP

			WITHOUT PROJECT						ALTERNATIVE B			ALTERNATIVES E, F, and J			ALTERNATIVES K and L		
			YEAR 2000 -1,609 TOWS			YEAR 2050 - 1,505 TOWS			YEAR 2050 - 1,738 TOWS			YEAR 2050 - 2,120 TOWS			YEAR 2050 - 2,346 TOWS		
BW Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
BW1	799	noncohesive	0.0001	0.00019	BLUE	0.0001	0.00018	BLUE	0.0001	0.00021	BLUE	0.0001	0.00025	BLUE	0.0001	0.00028	BLUE
BW1			0.0049			0.0046			0.0053			0.0065			0.0072		
BW1			0.0000			0.0000			0.0000			0.0000			0.0000		
BW2	614	cohesive-med	2.6785	0.13301	YELLOW	2.5080	0.12454	YELLOW	2.8946	0.14374	YELLOW	3.5292	0.17525	YELLOW	3.9054	0.19393	YELLOW
BW2			0.0009			0.0008			0.0009			0.0011			0.0013		
BW3	3963	cohesive-med	0.0000	0.00093	BLUE	0.0000	0.00087	BLUE	0.0000	0.00100	BLUE	0.0001	0.00122	BLUE	0.0001	0.00136	BLUE
BW3			0.0653			0.0611			0.0705			0.0860			0.0952		
BW3			0.0068			0.0064			0.0074			0.0090			0.0099		
BW3			0.0000			0.0000			0.0000			0.0000			0.0000		
BW3			0.0002			0.0002			0.0002			0.0002			0.0002		
BW3			0.0485			0.0454			0.0524			0.0639			0.0707		
BW4	631	cohesive-med	0.0236	0.00114	BLUE	0.0221	0.00107	BLUE	0.0255	0.00123	BLUE	0.0311	0.00150	BLUE	0.0344	0.00166	BLUE
BW6	721	noncohesive	0.0000	0.02555	BLUE	0.0000	0.02389	BLUE	0.0000	0.02759	BLUE	0.0000	0.03366	BLUE	0.0000	0.03725	BLUE
BW6			0.5749			0.5376			0.6208			0.7574			0.8382		
BW6			0.0295			0.0276			0.0319			0.0389			0.0430		

Note: To convert acres to square meters, multiply by 4,046.873. To convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] BW 5 not included since it is an Impounded Backwater.

TABLE 6. SEDIMENTS TO SECONDARY CHANNELS, MISSISSIPPI RIVER POOL 8

BASED ON 50% ROLLUP

				WITHOUT PROJECT						ALTERNATIVE B			ALTERNATIVES E, F, and J			ALTERNATIVES K and L		
				YEAR 2000 - 1,609 TOWS			YEAR 2050 - 1,505 TOWS			YEAR 2050 - 1,738 TOWS			YEAR 2050 - 2,120 TOWS			YEAR 2050 - 2,346 TOWS		
SEC Number	WATER AREA (acres)	AVG. DEPTH (ft)	ADJACENT SEDIMENT TYPE	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
SEC1	125	6.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC2	44	3.2	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC3	58	3.1	noncohesive	0.0001	0.00006	BLUE	0.0001	0.00005	BLUE	0.0001	0.00006	BLUE	0.0001	0.00007	BLUE	0.0002	0.00008	BLUE
SEC4	24	5.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC5	88	7.9	cohesive-med	0.0003	0.00012	BLUE	0.0003	0.00011	BLUE	0.0004	0.00013	BLUE	0.0004	0.00015	BLUE	0.0005	0.00017	BLUE
SEC6	33	2.6	cohesive-med	0.0080	0.00743	BLUE	0.0075	0.00695	BLUE	0.0087	0.00802	BLUE	0.0106	0.00979	BLUE	0.0117	0.01084	BLUE
SEC7	25	2.2	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00001	BLUE
SEC8	10	7.5	cohesive-med	0.0236	0.07202	BLUE	0.0221	0.06734	BLUE	0.0255	0.07778	BLUE	0.0311	0.09479	BLUE	0.0344	0.10499	YELLOW

Note: To convert acres to square meters, multiply by 4,046.873; to convert feet to meters, multiply by 0.3048; to convert acre-ft/year to cu m/year, multiply by 1,233.49.

TABLE 7. SEDIMENTS TO BACKWATERS, MISSISSIPPI RIVER POOL 13

BASED ON 50% ROLLUP

			WITHOUT PROJECT						ALTERNATIVE B			ALTERNATIVES E, F, and J			ALTERNATIVES K and L		
			YEAR 2000 - 2,361 TOWS			YEAR 2050 - 2,451 TOWS			YEAR 2050 - 2,768 TOWS			YEAR 2050 - 3,280 TOWS			YEAR 2050 - 3,576 TOWS		
BW Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
BW1	746	cohesive-med	0.0007	0.00003	BLUE	0.0007	0.00003	BLUE	0.0008	0.00003	BLUE	0.0010	0.00004	BLUE	0.0011	0.00004	BLUE
BW1			0.0000			0.0000			0.0000			0.0000			0.0000		
BW2	33	noncohesive	0.0039	0.00358	BLUE	0.0040	0.00372	BLUE	0.0045	0.00420	BLUE	0.0054	0.00496	BLUE	0.0059	0.00542	BLUE
BW3	83	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW4	876	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW4			0.0000			0.0000			0.0000			0.0000			0.0000		
BW5	782	cohesive-med	0.0000	0.01984	BLUE	0.0000	0.02061	BLUE	0.0000	0.02327	BLUE	0.0000	0.02754	BLUE	0.0000	0.03006	BLUE
BW5			0.3235			0.3360			0.3795			0.4490			0.4902		
BW5			0.1849			0.1920			0.2169			0.2566			0.2801		
BW5			0.0007			0.0007			0.0008			0.0010			0.0010		
BW6	934	cohesive-soft	0.4754	0.01552	BLUE	0.4936	0.01611	BLUE	0.5576	0.01820	BLUE	0.6599	0.02153	BLUE	0.7202	0.02350	BLUE
BW7	399	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW7			0.0000			0.0000			0.0000			0.0000			0.0000		
BW7			0.0000			0.0000			0.0000			0.0000			0.0000		
BW7			0.0000			0.0000			0.0000			0.0000			0.0000		
BW7			0.0000			0.0000			0.0000			0.0000			0.0000		
BW9	127	cohesive-med	0.0008	0.00020	BLUE	0.0008	0.00020	BLUE	0.0010	0.00023	BLUE	0.0011	0.00027	BLUE	0.0012	0.00030	BLUE
BW10	1181	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW10			0.0000			0.0000			0.0000			0.0000			0.0000		
BW10			0.0000			0.0000			0.0000			0.0000			0.0000		
BW10			0.0000			0.0000			0.0000			0.0000			0.0000		
BW10			0.0000			0.0000			0.0000			0.0000			0.0000		
BW11	1122	cohesive-soft	0.0132	0.45104	YELLOW	0.0138	0.46827	YELLOW	0.0156	0.52884	YELLOW	0.0184	0.62604	YELLOW	0.0201	0.68313	YELLOW
BW11			0.0106			0.0110			0.0124			0.0147			0.0160		
BW11			0.3117			0.3238			0.3657			0.4327			0.4722		
BW11			0.3414			0.3546			0.4006			0.4739			0.5172		
BW11			0.2089			0.2169			0.2449			0.2899			0.3164		
BW11			4.0602			4.2145			4.7596			5.6352			6.1490		
BW11			11.6572			12.1029			13.6683			16.1802			17.6559		

Note: To convert acres to square meters, multiply by 4,046.873. To convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] BW8 not included since it is part of a game refuge.

TABLE 8. SEDIMENTS TO SECONDARY CHANNELS, MISSISSIPPI RIVER POOL 13

BASED ON 50% ROLLUP

				WITHOUT PROJECT						ALTERNATIVE B			ALTERNATIVES E, F, and J			ALTERNATIVES K and L		
				YEAR 2000 - 2,361 TOWS			YEAR 2050 - 2,451 TOWS			YEAR 2050 - 2,768 TOWS			YEAR 2050 - 3,280 TOWS			YEAR 2050 - 3,576 TOWS		
SEC Number	WATER AREA (acres)	AVG. DEPTH (ft)	ADJACENT SEDIMENT TYPE	LOAD into SEC (acre-ft/yr	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (acre-ft/yr	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (acre-ft/yr	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (acre-ft/yr	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (acre-ft/yr	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
SEC1	124	5.3	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC2	69	5.4	cohesive-med	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE
SEC3	4	1.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC4	20	6.3	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC5	39	2.9	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC6	28	4.0	cohesive-med	0.0000	0.00003	BLUE	0.0000	0.00003	BLUE	0.0000	0.00003	BLUE	0.0000	0.00003	BLUE	0.0000	0.00004	BLUE
SEC7	333	6.1	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC8	79	8.5	cohesive-soft	0.3126	0.12061	YELLOW	0.3246	0.12525	YELLOW	0.3666	0.14146	YELLOW	0.4347	0.16771	YELLOW	0.4736	0.18274	YELLOW
SEC9	39	2.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC10	48	6.5	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC11	44	3.8	cohesive-med	0.0008	0.00057	BLUE	0.0008	0.00059	BLUE	0.0010	0.00066	BLUE	0.0011	0.00079	BLUE	0.0012	0.00086	BLUE
SEC12	28	2.9	cohesive-med	0.2393	0.26049	YELLOW	0.2484	0.27042	YELLOW	0.2805	0.30539	YELLOW	0.3326	0.36209	YELLOW	0.3624	0.39454	YELLOW

Note: To convert acres to square meters, multiply by 4,046.873; to convert feet to meters, multiply by 0.3048; to convert acre-ft/year to cu m/year, multiply by 1,233.49.

TABLE 9. SEDIMENTS TO BACKWATERS, MISSISSIPPI RIVER POOL 26

BASED ON 50% ROLLUP

			WITHOUT PROJECT						ALTERNATIVE B		
(UPSTREAM of IWW)			YEAR 2000 - 3,792 TOWS			YEAR 2050 - 4,088 TOWS			YEAR 2050 - 4,692 TOWS		
(DOWNSTREAM of IWW)			YEAR 2000 - 8,589 TOWS			YEAR 2050 - 11,033 TOWS			YEAR 2050 - 11,691 TOWS		
BW Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
POOL 26 UPSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY											
BW1	379	cohesive-med	0.0000	0.00076	BLUE	0.0000	0.00082	BLUE	0.0000	0.00092	BLUE
BW1			0.0094			0.0102			0.0115		
BW2	157	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW2			0.0000			0.0000			0.0000		
BW6	690	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW6			0.0000			0.0000			0.0000		
BW7	33	cohesive-med	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE
POOL 26 DOWNSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY											
BW8	100	cohesive-med	0.0013	0.00039	BLUE	0.0016	0.00050	BLUE	0.0017	0.00053	BLUE
BW9	73	cohesive-med	0.0024	0.00101	BLUE	0.0031	0.00130	BLUE	0.0033	0.00137	BLUE
BW10	85	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW11	340	cohesive-med	0.0236	0.00211	BLUE	0.0303	0.00272	BLUE	0.0321	0.00288	BLUE
BW12	227	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE

			ALTERNATIVE E			ALTERNATIVE J			ALTERNATIVE K		
(UPSTREAM of IWW)			YEAR 2050 - 5,597 TOWS			YEAR 2050 - 5,607 TOWS			YEAR 2050 - 5,904 TOWS		
(DOWNSTREAM of IWW)			YEAR 2050 - 12,675 TOWS			YEAR 2050 - 13,143 TOWS			YEAR 2050 - 13,492 TOWS		
BW Number	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
POOL 26 UPSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY											
BW1	379	cohesive-med	0.0000	0.00112	BLUE	0.0000	0.00112	BLUE	0.0000	0.00118	BLUE
BW1			0.0139			0.0139			0.0147		
BW2	157	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW2			0.0000			0.0000			0.0000		
BW6	690	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW6			0.0000			0.0000			0.0000		
BW7	33	cohesive-med	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE
POOL 26 DOWNSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY											
BW8	100	cohesive-med	0.0019	0.00058	BLUE	0.0020	0.00060	BLUE	0.0020	0.00062	BLUE
BW9	73	cohesive-med	0.0036	0.00149	BLUE	0.0037	0.00154	BLUE	0.0038	0.00158	BLUE
BW10	85	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW11	340	cohesive-med	0.0348	0.00312	BLUE	0.0361	0.00323	BLUE	0.0370	0.00332	BLUE
BW12	227	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE

Note: To convert acres to square meters, multiply by 4,046.873. To convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] BW3,BW4, and BW5 not included since they are on Illinois Waterway.

TABLE 10. SEDIMENTS TO SECONDARY CHANNELS, MISSISSIPPI RIVER POOL 26												
BASED ON 50% ROLLUP												
				WITHOUT PROJECT						ALTERNATIVE B		
(UPSTREAM of IWW)				YEAR 2000 - 3,792 TOWS			YEAR 2050 - 4,088 TOWS			YEAR 2050 - 4,692 TOWS		
(DOWNSTREAM of IWW)				YEAR 2000 - 8,589 TOWS			YEAR 2050 - 11,033 TOWS			YEAR 2050 - 11,691 TOWS		
SEC Number[1]	WATER AREA (acres)	AVG. DEPTH (ft)	ADJACENT SEDIMENT TYPE	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
POOL 26 UPSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY												
SEC1	51	4.4	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC2	408	4.6	noncohesive	0.0009	0.00007	BLUE	0.0009	0.00007	BLUE	0.0011	0.00008	BLUE
SEC3	56	4.5	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC4	25	7.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC5	588	12.3	noncohesive	0.0002	0.00001	BLUE	0.0002	0.00001	BLUE	0.0002	0.00001	BLUE
SEC5				0.0000			0.0000			0.0000		
SEC5				0.0000			0.0000			0.0000		
POOL 26 DOWNSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY												
SEC9	81	12.4	cohesive-med	0.0001	0.00003	BLUE	0.0001	0.00004	BLUE	0.0001	0.00004	BLUE
SEC10	243	15.6	cohesive-med	0.0016	0.00021	BLUE	0.0021	0.00027	BLUE	0.0022	0.00028	BLUE
SEC11	586	9.2	cohesive-med	0.0067	0.00035	BLUE	0.0086	0.00045	BLUE	0.0091	0.00047	BLUE
				ALTERNATIVE E			ALTERNATIVE J			ALTERNATIVE K		
(UPSTREAM of IWW)				YEAR 2050 - 5,597 TOWS			YEAR 2050 - 5,607 TOWS			YEAR 2050 - 5,904 TOWS		
(DOWNSTREAM of IWW)				YEAR 2050 - 12,675 TOWS			YEAR 2050 - 13,143 TOWS			YEAR 2050 - 13,492 TOWS		
SEC Number	WATER AREA (acres)	AVG. DEPTH (ft)	ADJACENT SEDIMENT TYPE	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
POOL 26 UPSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY												
SEC1	51	4.4	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC2	408	4.6	noncohesive	0.0013	0.00010	BLUE	0.0013	0.00010	BLUE	0.0014	0.00010	BLUE
SEC3	56	4.5	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC4	25	7.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC5	588	12.3	noncohesive	0.0003	0.00002	BLUE	0.0003	0.00002	BLUE	0.0003	0.00002	BLUE
SEC5				0.0000			0.0000			0.0000		
SEC5				0.0000			0.0000			0.0000		
POOL 26 DOWNSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY												
SEC9	81	12.4	cohesive-med	0.0001	0.00005	BLUE	0.0001	0.00005	BLUE	0.0001	0.00005	BLUE
SEC10	243	15.6	cohesive-med	0.0024	0.00030	BLUE	0.0025	0.00032	BLUE	0.0026	0.00032	BLUE
SEC11	586	9.2	cohesive-med	0.0099	0.00051	BLUE	0.0102	0.00053	BLUE	0.0105	0.00055	BLUE
Note: To convert acres to square meters, multiply by 4,046.873; to convert feet to meters, multiply by 0.3048; to convert acre-ft/year to cu m/year, multiply by 1,233.49.												
[1] SEC6, SEC7, and SEC8 not included since they cross over into the Illinois Waterway.												

the confluence is significantly greater than upstream of the confluence. Computations indicate that all backwaters are BLUE for without-project and all alternatives. It should be noted that backwaters BW3, BW4, and BW5 were not included in these calculations as these backwaters were considered as part of the analysis for the Illinois Waterway. All of the secondary channels in Pool 26 had negligible sediment delivered and have impact color BLUE. Three secondary channels (SEC6, SEC7, and SEC8) were not included in the computations since their inlets are on the Mississippi River and their outlets on the Illinois Waterway.

Analysis of trend pool sedimentation

Analysis of the results of computations of the trend pools and various input parameters indicated the volume of sediment delivered to any specific backwater or secondary channel by tows is dependent on the following factors:

a. The type of sediment adjacent to the inlet.

b. The distance of the inlet from the sailing line.

c. The water depth in the cell adjacent to the inlet.

d. The width of the inlet.

e. The discharge into the inlet of contiguous backwaters or secondary channels.

f. Sediment time-history concentrations from waves, return currents, and the propeller jet.

g. The number of tows.

For instance, in Pool 4 the highest inflow into any backwater, based on the discharges obtained in the TABS-2 studies, was about 2,000 cfs (56.6 cu m/sec) for the high river stage. In BW2 in Pool 8, which was colored YELLOW, the discharge into the backwater was over 6,000 cfs (169.9 cu m/sec). In Pool 13 SEC8 had a discharge as high as 9,000 cfs (254.9 cu m/sec) and was colored YELLOW. Conversely, SEC12 in Pool 13 was colored YELLOW, but the highest discharge into it was about 1,500 cfs (42.5 cu m/sec). However, the inlet to SEC12 was relatively close to the sailing line (about 80 m), which created larger sediment concentrations.

Extrapolation to Mississippi River nontrend pools

Extrapolation of the potential impacts to backwaters and secondary channels for Pools 5 through 25 was based on the impacts determined for Pools 4, 8, 13, and 26 discussed previously. To assist in the extrapolation, data were organized in Tables 11 and 12 for Pools 8 and 13, respectively. These were the trend pools that had potential impacts other than BLUE. The tables included computations of the annual sediment load per inlet width (last column).

A review of the worksheets used in the extrapolations for the Mississippi River (Tables 11 and 12) indicated that another level of significance existed in the annual load per inlet width. Dividing the annual load delivered to an inlet by the width of the inlet produces a unit load for the inlet. From that review it was apparent that the data tended to separate around a value of 0.01 acre-ft/year/m (12.3 cu m/year/m). Therefore, it was decided that the unit load value of

Table 11
Worksheet for Extrapolation to Nontrend Pools on Upper Mississippi River, Pool 8

Feature	Actual RM	Sediment Type	MSLD[1] m	Inlet Width m	Sediment Load acre-ft/year	Annual Load/Width acre-ft/m
Backwaters						
BKW01_01	701.7	noncohesive	120	232.6	0.0001	0.000000
BKW01_02	701.5	noncohesive	130	241.9	0.0049	0.000020
BKW01_05	698.7	noncohesive	100	98.7	0.0000	0.000000
BKW02_01	969.6	cohesive-medium	230	188.9	2.6785	0.014179
BKW02_02	696.4	cohesive-medium	240	184.5	0.0009	0.000005
BKW03_01	694.8	cohesive-medium	220	387.5	0.0068	0.000018
BKW03_02	694.4	cohesive-medium	140	102.5	0.0000	0.000000
BKW03_03	694.2	cohesive-medium	100	148.8	0.0485	0.000326
BKW03_05	691.8	noncohesive	310	109.6	0.0000	0.000000
BKW03_07	691.2	noncohesive	110	173.7	0.0653	0.000376
BKW03_11	689	noncohesive	340	166.1	0.0002	0.000001
BKW04_01	690.3	cohesive-medium	240	181.3	0.0236	0.000130
BKW06_02	687.7	noncohesive	140	103	0.0295	0.000287
BKW06_03	687	noncohesive	100	873	0.5749	0.000659
Secondary Channels						
SEC01_01	699.2	noncohesive	190	333.9	0.0000	0.000000
SEC03_01	688.5	noncohesive	230	548	0.0001	0.000000
SEC04_01	701	noncohesive	190	217.9	0.0000	0.000000
SEC05_01	695.8	cohesive-medium	190	225.2	0.0003	0.000001
SEC06_01	694.9	cohesive-medium	300	97.9	0.0080	0.000082
SEC07_01	691.5	cohesive-medium	240	122	0.0000	0.000000
SEC08_01	690.6	cohesive-medium	240	144	0.0236	0.000164

Note: To convert acre-ft to cu m, multiply by 1,233.49.
[1] Distance to the middle sailing line.

0.01 acre-ft/year/m (12.3 cu m/year/m) would also be used as a level of significance and would be used to delineate a medium (YELLOW) potential impact.

Using the information in Tables 11 and 12 and some additional computations with the adjacent sediment type, a family of curves was developed for cohesive-medium sediments that associated annual sediment load per inlet width to distance from the sailing line. These generic curves were based on a unit discharge in the inlet of 0.3 m^3/sec/m and for water depths at the inlet of 0.6, 0.8, 1.0, 1.5, 2.0, and 3.0 m (Plate 6). The curves presented are the distance to the sailing line (in meters) plotted against the annual unit load (units of acre-feet/year/meter). These curves were then used for extrapolation to the nontrend Mississippi River pools.

Before the extrapolation, the NAVEFF and NAVSED programs were run for the nontrend pools. From those results the distance from the center sailing line to

Table 12
Worksheet for Extrapolation to Nontrend Pools on Upper Mississippi River, Pool 13

Feature	Actual RM	Sediment Type	MSLD[1] m	Inlet Width m	Sediment Load acre-ft/year	Annual Load/Width acre-ft/m
Backwaters						
BKW01_01	555.9	cohesive-medium	310	91	0.0000	0.000000
BKW01_02	555.7	cohesive-medium	120	121.5	0.0007	0.000006
BKW02_01	552.1	noncohesive	70	133	0.0039	0.000029
BKW03_01	547.4	cohesive-medium	210	267.9	0.0000	0.000000
BKW04_01	546.2	noncohesive	170	27	0.0000	0.000000
BKW04_02	545.4	cohesive-medium	250	37.6	0.0000	0.000000
BKW05_03	540.1	cohesive-medium	270	49.5	0.0000	0.000000
BKW05_05	539.1	cohesive-medium	60	243.5	0.1849	0.000759
BKW05_06	538.9	cohesive-medium	50	233.6	0.3235	0.001385
BKW05_07	538.6	cohesive-medium	70	142.1	0.0007	0.000005
BKW06_01	541	cohesive-soft	130	420.6	0.4754	0.001130
BKW07_01	537	noncohesive	270	208.3	0.0000	0.000000
BKW07_03	534.7	noncohesive	250	137	0.0000	0.000000
BKW07_04	534.4	noncohesive	240	79.5	0.0000	0.000000
BKW07_05	533.9	noncohesive	550	64.6	0.0000	0.000000
BKW07_06	533.5	noncohesive	650	113	0.0000	0.000000
BKW09_01	534.5	cohesive-medium	380	23	0.0008	0.000036
BKW10_01	533.3	noncohesive	230	444.5	0.0000	0.000000
BKW10_03	531.3	noncohesive	200	51.6	0.0000	0.000000
BKW10_04	531.2	noncohesive	100	48.1	0.0000	0.000000
BKW10_05	530.8	noncohesive	130	115	0.0000	0.000000
BKW10_07	530.2	noncohesive	640	153.9	0.0000	0.000000
BKW11_01	532.6	cohesive-soft	540	59	0.3117	0.005284
BKW11_02	532.7	cohesive-soft	530	44.1	0.0106	0.000240
BKW11_03	532.7	cohesive-soft	520	35.9	0.0132	0.000366
BKW11_07	532.3	cohesive-soft	110	185	4.0602	0.021947
BKW11_08	530.8	cohesive-soft	540	1126.8	0.3414	0.000303
BKW11_09	530.1	cohesive-soft	120	52.1	0.2089	0.004009
BKW11_12	528.8	cohesive-soft	80	478.9	11.6572	0.024342
Secondary Channels						
SEC01_01	555.5	noncohesive	370	417.6	0.0000	0.000000
SEC02_01	554.4	cohesive-medium	110	439.8	0.0000	0.000000
SEC03_01	553	noncohesive	220	24	0.0000	0.000000
SEC04_01	552.6	noncohesive	330	98	0.0000	0.000000
SEC05_01	550.1	noncohesive	470	84	0.0000	0.000000
SEC06_03	548.2	cohesive-medium	300	164.9	0.0000	0.000000
SEC07_01	546.8	cohesive-medium	440	263.4	0.0000	0.000000
SEC08_01	543.6	cohesive-medium	60	473.7	0.3126	0.000660
SEC09_01	541.2	noncohesive	220	96.8	0.0000	0.000000
SEC10_01	537	cohesive-medium	480	216.7	0.0000	0.000000
SEC11_01	534.5	cohesive-medium	380	23.9	0.0008	0.000034
SEC12_01	532.8	cohesive-medium	80	140.7	0.2393	0.001701

Note: To convert acre-ft to cu m, multiply by 1,233.49.
[1] Distance to the middle sailing line.

the inlet, water depth at the inlet, and sediment concentration at the inlet were determined. Distances and depths were based on the NAVEFF cells rather than actual measurements. This approach was used since the tow effects (from NAVEFF) and sediment resuspension (from NAVSED) were based on these cells. Therefore, the cells were used as the basis for all riverine parameters. The most difficult part in extrapolation to nontrend pool backwaters and secondary channels is having no discharge data into that area. The approach taken for the nontrend pools was to review the available information on each inlet and then attempt to associate it with a similar backwater or secondary channel in one of the trend pools.

Extrapolation to nontrend pools was initiated by tabulating the river miles associated with each backwater and secondary channel, location on the right or left bank (looking downstream), attribute designation (backwater or secondary channel), adjacent bed material classification, distance to the sailing line (from NAVSED), and water depth at the inlet (from NAVEFF). These are the data presented in Table 13. The extrapolation consisted of visually inspecting the location and configuration of the backwater or secondary channel on the GIS maps prepared by EL, reviewing the data presented in Tables 11 and 12 (trend pool data), and reviewing the cell sediment concentrations (nontrend pool data) and the family of annual load per inlet width versus sailing line distance curves. Using this information, linkages between the trend pool and nontrend pool backwater were established. Each nontrend pool backwater or secondary channel inlet was analyzed using this procedure.

It should be noted that in the trend pools the traffic projections for the various alternatives were used in the computations to determine the quantity of sediments entering a backwater or secondary channel. In the nontrend pools or reaches no specific traffic or traffic projections for the various alternatives were used. The extrapolation from trend pools to nontrend pools was based on identifying similar conditions that had the potential for being impacted. Therefore, if a backwater or secondary channel inlet in a nontrend pool had conditions similar to one in a trend pool, that nontrend pool inlet was designated as having a similar potential for impact.

As an example of the procedure used in the extrapolation and development of the linkage between the Mississippi River trend and nontrend pools, reference is made to backwater BW2 on the right side of the channel in Pool 5 at river mile 752 (Table 13). A review of that specific backwater inlet shows medium, cohesive sediment is adjacent to the inlet, the distance to the sailing line is 210 m, and the water depth at the inlet is approximately 0.6 m. Using those data and Plate 6 results in an annual unit sediment load of slightly more than 0.02 acre-ft/year/m (24.7 cu m/year/m). Since this is greater than the unit level of significance of 0.01 acre-ft/year/m (12.3 cu m/year/m) set previously, the inlet and associated backwater were classified as having a medium potential for impacts and were colored YELLOW. Another example with similar conditions is presented for the inlet to backwater BW6 on the right side of the channel in Pool 5 at river mile 749 (Table 13). In this case the inlet shows adjacent medium, cohesive sediment, the distance to the sailing line is 180 m, and the water depth at the inlet is approximately 0.6 m. Using these data and Plate 6 gives an annual unit sediment load of approximately 0.023 acre-ft/year/m

Table 13
Extrapolation to Mississippi River Nontrend Pools 5 Through 25, Backwater and Secondary Channels

River Mile	Associated Attribute	Adjacent Sediment	Distance To Sailing Line m	Depth at Inlet m	Impact Color
Pool 5, River Miles 753-738					
753R	BW1	cohesive-medium	NO DATA AVAILABLE		
752R	BW2	cohesive-medium	210	0.61	YELLOW
751L	BW3	noncohesive	100	1.73	BLUE
750R	BW6	cohesive-medium	120	2.23	BLUE
749R	BW6	cohesive-medium	180	0.64	BLUE
750L	BW7	noncohesive	170	0.43	BLUE
749L	BW4	noncohesive	200	0.44	BLUE
748L	BW4	noncohesive	200		BLUE
747L	BW4	cohesive-medium	150	0.64	YELLOW
746L	BW4	cohesive-medium	70	4.72	YELLOW
747R	BW5	noncohesive	100	1.84	BLUE
747R	BW5	noncohesive	100	1.84	BLUE
746R	BW5	noncohesive	190	2.22	BLUE
	no SEC				
Pool 5A, River Miles 738-729					
737L	BW1	noncohesive	140	0.79	BLUE
737R	BW2	noncohesive	120	0.76	BLUE
737R	BW2	noncohesive	120	0.76	BLUE
737R	BW2	noncohesive	120	0.76	BLUE
736R	BW2	noncohesive	150	0.56	BLUE
735R	BW2	noncohesive	160	0.46	BLUE
734R	BW2	noncohesive	100	2.40	BLUE
733R	BW2	noncohesive	200	1.90	BLUE
732R	BW2	noncohesive	160	2.16	BLUE
732L	BW3	noncohesive	170	3.96	BLUE
731L	BW4	noncohesive	90	3.65	BLUE
732L	SEC1	noncohesive	170	3.96	BLUE
Pool 6, River Miles 728-714					
728L	BW2	noncohesive	120	2.73	BLUE
728L	BW2	noncohesive	120	2.73	BLUE
727L	BW2	noncohesive	230	0.75	BLUE
726L	BW2	noncohesive	170	0.67	BLUE
725L	BW2	noncohesive	140	4.63	BLUE
724L	BW2	noncohesive	150	1.62	BLUE
723L	BW2	noncohesive	180	2.42	BLUE
728R	BW1	noncohesive	160	1.08	YELLOW
727R	BW1	noncohesive	60	4.11	YELLOW
723R	BW3	noncohesive	100	2.08	BLUE
719R	BW4	noncohesive	350	0.95	BLUE
719R	BW4	noncohesive	350	0.95	BLUE
719R	BW4	noncohesive	350	0.95	BLUE
719R	BW4	noncohesive	350	0.95	BLUE
718L	BW5	noncohesive	200	1.23	BLUE
718L	BW5	noncohesive	200	1.23	BLUE
716L	BW6	noncohesive	200	2.21	BLUE
	no SEC				
Pool 7, River Miles 714-703					
714R	BW1	noncohesive	170	1.95	BLUE
714R	BW1	noncohesive	170	1.95	BLUE
709L	BW2	noncohesive	470	2.14	BLUE

(Sheet 1 of 7)

Table 13 (Continued)					
River Mile	Associated Attribute	Adjacent Sediment	Distance To Sailing Line m	Depth at Inlet m	Impact Color
Pool 7, River Miles 714-703 (Cont.)					
709L	BW2	noncohesive	470	2.14	BLUE
708L	BW2	noncohesive	180	1.14	BLUE
707L	BW2	noncohesive	420	3.10	BLUE
707L	BW2	noncohesive	420	3.10	BLUE
707L	BW2	noncohesive	420	3.10	BLUE
712L	BW3	noncohesive	180	1.94	BLUE
713L	SEC1	noncohesive	190	0.97	BLUE
713R	SEC2	noncohesive	150	1.92	BLUE
712L	SEC3	noncohesive	180	1.13	BLUE
705L	SEC4	noncohesive	OLD MAIN CHANNEL		BLUE
Pool 9, River Miles 679-648					
677R	BW1	noncohesive	140	2.82	BLUE
675R	BW1	noncohesive	60	4.58	BLUE
675R	BW1	noncohesive	60	4.58	BLUE
675R	BW1	noncohesive	60	4.58	BLUE
676L	BW2	noncohesive	130	2.30	BLUE
676L	BW2	noncohesive	130	2.30	BLUE
675L	BW2	noncohesive	170	1.44	BLUE
671R	BW4	cohesive-medium	120	1.24	YELLOW
670R	BW4	cohesive-medium	110	1.37	YELLOW
670R	BW4	cohesive-medium	110	1.37	YELLOW
669R	BW4	cohesive-medium	80	2.71	BLUE
669R	BW4	cohesive-medium	80	2.71	BLUE
668R	BW4	cohesive-medium	310	2.52	BLUE
666R	BW4	noncohesive	60	3.82	BLUE
668L	BW3	noncohesive	190	1.88	BLUE
667L	BW5	noncohesive	230	0.78	BLUE
666L	BW5	noncohesive	230	0.84	BLUE
665L	BW5	noncohesive	100	3.18	BLUE
665L	BW5	noncohesive	100	3.18	BLUE
664L	BW5	noncohesive	170	0.98	BLUE
664L	BW5	noncohesive	170	0.98	BLUE
678L	SEC1	noncohesive	110	3.01	BLUE
672R	SEC2	cohesive-medium	260	1.01	BLUE
671L	SEC3	noncohesive	50	4.35	YELLOW
Pool 10, River Miles 647-616					
647R	BW1	noncohesive	170	2.03	BLUE
646R	BW1	noncohesive	80	2.09	BLUE
644R	BW1	noncohesive	70	2.52	BLUE
647L	BW2	noncohesive	260	2.63	BLUE
644L	BW3	noncohesive	170	1.72	BLUE
644L	BW3	noncohesive	170	1.72	BLUE
642L	BW4	noncohesive	90	2.15	BLUE
639L	BW4	noncohesive	270	1.74	BLUE
638L	BW4	noncohesive	180	1.60	BLUE
636R	BW5	noncohesive	90	5.63	BLUE
635R	BW5	noncohesive	70	2.11	BLUE
635L	BW6	noncohesive	150	1.61	BLUE
634L	BW6	noncohesive	220	6.25	BLUE
633L	BW6	noncohesive	240	1.61	BLUE
631L	BW7	noncohesive	TRIBUTARY		BLUE
630R	BW8	noncohesive	430	1.46	BLUE
					(Sheet 2 of 7)

Table 13 (Continued)					
River Mile	**Associated Attribute**	**Adjacent Sediment**	**Distance To Sailing Line m**	**Depth at Inlet m**	**Impact Color**
Pool 10, River Miles 647-616 (Cont.)					
629R	BW8	noncohesive	580	1.39	BLUE
628R	BW8	noncohesive	310	1.11	BLUE
627R	BW8	noncohesive	130	2.44	BLUE
626L	BW9	noncohesive	200	1.47	BLUE
625L	BW9	noncohesive	400	1.07	BLUE
623L	BW9	noncohesive	270	2.79	BLUE
622L	BW9	cohesive-medium	140	2.76	BLUE
621L	BW9	cohesive-medium	110	2.02	BLUE
620L	BW9	cohesive-medium	200	2.58	BLUE
620R	BW10	cohesive-medium	120	0.88	YELLOW
620R	BW10	cohesive-medium	120	0.88	YELLOW
619R	BW10	cohesive-medium	140	3.70	BLUE
619R	BW10	cohesive-medium	140	3.70	BLUE
628L	SEC1	noncohesive	270	2.31	BLUE
624L	SEC2	noncohesive	130	0.83	BLUE
Pool 11, River Miles 615-583					
614L	BW1	noncohesive	70	6.04	YELLOW
613L	BW1	noncohesive	170	1.90	BLUE
613R	BW2	noncohesive	130	3.10	BLUE
612R	BW3	noncohesive	70	4.46	YELLOW
611R	BW4	noncohesive	250	2.34	BLUE
610R	BW4	noncohesive	140	1.30	BLUE
606L	BW6	noncohesive	220	2.83	BLUE
604L	BW6	noncohesive	90	0.80	BLUE
605R	BW5	noncohesive	100	1.07	BLUE
603R	BW7	noncohesive	200	3.75	BLUE
602L	BW8	cohesive-medium	110	5.80	BLUE
601L	BW8	cohesive-medium	270	1.12	BLUE
599L	BW8	cohesive-medium	290	1.42	BLUE
596L	BW8	cohesive-medium	220	4.80	BLUE
589R	BW9	noncohesive	100	0.50	BLUE
589R	BW9	noncohesive	100	0.50	BLUE
613L	SEC1	noncohesive	100	3.70	BLUE
Pool 12, River Miles 583-557					
583L	BW1	noncohesive	430	2.78	BLUE
583L	BW1	noncohesive	430	2.78	BLUE
582R	BW2	noncohesive	120	10.97	BLUE
579L	BW3	noncohesive	210	2.61	BLUE
578L	BW4	noncohesive	260	2.46	BLUE
577L	BW4	noncohesive	300	2.14	BLUE
575R	BW5	noncohesive	210	3.67	BLUE
572L	BW6	cohesive-medium	110	2.65	BLUE
572L	BW6	cohesive-medium	110	2.65	BLUE
568L	BW7	cohesive-medium	130	1.91	BLUE
568L	BW8	cohesive-medium	130	1.91	BLUE
567L	BW8	cohesive-medium	270	1.88	BLUE
567L	BW8	cohesive-medium	270	1.88	BLUE
564L	BW8	cohesive-medium	410	3.85	BLUE
564L	BW8	cohesive-medium	410	3.85	BLUE
562L	BW8	cohesive-medium	250	1.89	BLUE
562R	BW9	cohesive-medium	260	4.89	BLUE
571L	SEC1	cohesive-medium	210	1.91	BLUE
					(Sheet 3 of 7)

Table 13 (Continued)					
River Mile	**Associated Attribute**	**Adjacent Sediment**	**Distance To Sailing Line m**	**Depth at Inlet m**	**Impact Color**
Pool 12, River Miles 583-557 (Cont.)					
570L	SEC1	cohesive-medium	250	1.77	BLUE
562R	SEC2	cohesive-medium	260	4.89	BLUE
Pool 14, River Miles 522-494					
522R	BW1	cohesive-medium	200	4.85	BLUE
520L	BW2	noncohesive	190	2.73	BLUE
519L	BW2	noncohesive	200	3.09	BLUE
518R	BW4	noncohesive	100	2.84	BLUE
516L	BW3	noncohesive	150	1.34	BLUE
513L	BW5	cohesive-medium	530	1.26	BLUE
513L	BW5	cohesive-medium	530	1.26	BLUE
511R	BW6	cohesive-medium	380	2.67	BLUE
508R	BW7	cohesive-medium	390	0.86	BLUE
506R	BW8	cohesive-medium	190	4.39	BLUE
519L	SEC1	noncohesive	200	3.09	BLUE
510R	SEC2	cohesive-medium	170	1.83	BLUE
506R	SEC3	cohesive-medium	190	4.39	BLUE
Pool 15, River Miles 493-483					
486L	BW1	cohesive-medium	500	1.47	BLUE
492L	SEC1	noncohesive	220	1.41	BLUE
Pool 16, River Miles 482-458					
480L	BW2	cohesive-medium	260	1.13	BLUE
478R	BW1	noncohesive	300	1.60	BLUE
477R	BW3	noncohesive	250	2.76	BLUE
477L	BW4	noncohesive	290	1.76	BLUE
476L	BW4	noncohesive	400	3.90	BLUE
472L	BW4	noncohesive	170	2.99	BLUE
468L	BW4	noncohesive	240	2.18	BLUE
467L	BW4	cohesive-medium	230	1.62	BLUE
467L	BW4	cohesive-medium	230	1.62	BLUE
465L	BW4	cohesive-medium	160	4.92	BLUE
462R	BW5	cohesive-medium	IMPOUNDED		N/A
463L	BW6	cohesive-medium	IMPOUNDED		N/A
	no SEC				
Pool 17, River Miles 457-438					
455L	BW1	noncohesive	190	4.63	BLUE
455L	BW1	noncohesive	190	4.63	BLUE
455L	BW1	noncohesive	190	4.63	BLUE
455L	BW1	noncohesive	190	4.63	BLUE
453L	BW1	noncohesive	210	1.08	BLUE
452L	BW1	noncohesive	190	1.01	BLUE
452L	BW1	noncohesive	190	1.01	BLUE
449L	BW1	noncohesive	220	0.93	BLUE
449L	BW1	noncohesive	220	0.93	BLUE
448R	BW2	cohesive-medium	330	1.18	BLUE
447R	BW2	cohesive-medium	220	1.04	BLUE
447L	BW3	noncohesive	170	3.14	BLUE
446L	BW3	noncohesive	160	1.20	BLUE
443L	BW3	noncohesive	100	3.88	BLUE
443R	BW4	cohesive-medium	410	2.08	BLUE
439R	BW6	cohesive-medium	280	1.79	BLUE
438R	BW6	cohesive-medium	430	0.96	BLUE
					(Sheet 4 of 7)

Table 13 (Continued)					
River Mile	**Associated Attribute**	**Adjacent Sediment**	**Distance To Sailing Line m**	**Depth at Inlet m**	**Impact Color**
Pool 17, River Miles 457-438 (Cont.)					
439L	BW5	cohesive-medium	190	6.10	BLUE
	no SEC				
Pool 18, River Miles 437-411					
437R	BW1	noncohesive	310	6.10	BLUE
436L	BW2	noncohesive	230	2.30	BLUE
433L	BW3	noncohesive	190	2.11	BLUE
433R	BW4	noncohesive	490	2.11	BLUE
431R	BW4	cohesive-medium	230	5.87	BLUE
430R	BW5	cohesive-medium	150	5.30	BLUE
429R	BW5	cohesive-medium	340	3.00	BLUE
427L	BW6	noncohesive	290	1.60	BLUE
426L	BW6	noncohesive	270	1.70	BLUE
426L	BW6	noncohesive	270	1.70	BLUE
425R	BW7	noncohesive	140	4.10	BLUE
425R	BW7	noncohesive	140	4.10	BLUE
424R	BW7	noncohesive	370	6.70	BLUE
423R	BW7	noncohesive	340	1.38	BLUE
422R	BW7	cohesive-medium	370	2.50	BLUE
422R	BW7	cohesive-medium	370	2.50	BLUE
422R	BW7	cohesive-medium	370	2.50	BLUE
420R	BW7	cohesive-medium	200	3.00	BLUE
423L	BW8	noncohesive	120	3.50	BLUE
423L	BW8	noncohesive	120	3.50	BLUE
420L	BW8	noncohesive	280	2.50	BLUE
420L	BW8	noncohesive	280	2.50	BLUE
419L	BW8	noncohesive	630	2.83	BLUE
	no SEC				
Pool 19, River Miles 410-364					
409R	BW1	cohesive-medium	120	3.86	BLUE
406L	BW2	noncohesive	230	3.33	BLUE
405L	BW2	noncohesive	250	1.29	BLUE
402L	BW9	cohesive-medium	360	2.17	BLUE
398L	BW9	cohesive-medium	250	1.92	BLUE
394L	BW9	noncohesive	260	1.05	BLUE
394L	BW9	noncohesive	260	1.05	BLUE
390L	BW9	noncohesive	340	1.97	BLUE
396R	BW3	noncohesive	230	1.34	BLUE
394R	BW4	noncohesive	350	5.55	BLUE
388R	BW8	cohesive-soft	780	1.18	BLUE
387L	BW5	noncohesive	570	0.84	BLUE
386L	BW6	noncohesive	270	1.00	BLUE
380R	BW7	cohesive-medium	1000	0.86	BLUE
399L	SEC1	cohesive-medium	390	1.56	BLUE
Pool 20, River Miles 364-344					
364L	BW1	noncohesive	450	1.10	BLUE
263L	BW2	noncohesive	330	1.44	BLUE
362L	BW2	cohesive-medium	510	3.80	BLUE
359R	BW3	cohesive-medium	160	2.92	BLUE
356L	BW4	noncohesive	190	2.23	BLUE
355L	BW4	noncohesive	630	2.26	BLUE
353L	BW4	noncohesive	570	1.03	BLUE
351R	BW5	noncohesive	440	2.40	BLUE
					(Sheet 5 of 7)

Table 13 (Continued)					
River Mile	**Associated Attribute**	**Adjacent Sediment**	**Distance To Sailing Line m**	**Depth at Inlet m**	**Impact Color**
Pool 20, River Miles 364-344 (Cont.)					
350L	BW6	noncohesive	170	2.10	BLUE
349L	BW6	noncohesive	530	4.06	BLUE
357R	SEC1	noncohesive	340	3.91	BLUE
347R	SEC2	noncohesive	100	8.10	BLUE
Pool 21, River Miles 343-325					
343L	BW1	noncohesive	LARGE	N/A	BLUE
342L	BW2	cohesive-medium	380	3.20	BLUE
340L	BW2	noncohesive	460	3.30	BLUE
333L	BW2	noncohesive	420	3.78	BLUE
329L	BW3	cohesive-medium	320	1.39	BLUE
325R	BW4	noncohesive	LARGE	N/A	BLUE
327L	SEC1	noncohesive	LARGE	N/A	BLUE
Pool 22, River Miles 325-302					
325R	BW1	noncohesive	350	2.50	BLUE
316L	BW2	noncohesive	180	2.80	BLUE
317R	BW3	noncohesive	230	2.39	BLUE
315R	BW3	noncohesive	340	2.74	BLUE
314L	BW4	noncohesive	160	2.24	BLUE
313L	BW4	noncohesive	320	2.08	BLUE
312L	BW4	noncohesive	350	2.08	BLUE
312R	BW5	noncohesive	190	2.99	BLUE
308L	BW6	cohesive-medium	420	4.99	BLUE
305L	BW7	cohesive-medium	280	1.67	BLUE
304L	BW8	cohesive-medium	410	2.74	BLUE
303L	BW9	cohesive-medium	300	1.16	BLUE
321L	SEC1	cohesive-medium	400	1.89	BLUE
309L	SEC2	noncohesive	430	1.60	BLUE
308L	SEC2	noncohesive	420	4.99	BLUE
306L	SEC3	cohesive-medium	800	5.09	BLUE
304L	SEC4	cohesive-medium	410	2.74	BLUE
Pool 24, River Miles 301-274					
300L	BW1	cohesive-medium	470	2.69	BLUE
299L	BW1	cohesive-medium	270	5.30	BLUE
298L	BW2	cohesive-medium	160	7.29	BLUE
295L	BW3	noncohesive	350	2.90	BLUE
290L	BW3	noncohesive	160	1.10	BLUE
283L	BW4	cohesive-medium	250	0.85	BLUE
282L	BW5	cohesive-medium	400	4.60	BLUE
275R	BW7	cohesive-medium	180	6.31	BLUE
299R	SEC1	noncohesive	130	3.40	BLUE
293R	SEC2	cohesive-medium	150	3.34	BLUE
Pool 25, River Miles 273-242					
273L	BW1	noncohesive	370	2.68	BLUE
271L	BW1	noncohesive	270	5.06	BLUE
268L	BW1	noncohesive	410	3.27	BLUE
264L	BW2	noncohesive	150	2.78	BLUE
267R	BW3	noncohesive	210	3.49	BLUE
266R	BW3	noncohesive	210	4.58	BLUE
265R	BW3	noncohesive	NO DATA AVAILABLE		BLUE
264L	BW4	noncohesive	150	2.78	BLUE
261R	BW5	noncohesive	110	1.91	BLUE
257L	BW6	noncohesive	390	1.50	BLUE
					(Sheet 6 of 7)

Table 13 (Concluded)					
River Mile	Associated Attribute	Adjacent Sediment	Distance To Sailing Line m	Depth at Inlet m	Impact Color
Pool 25, River Miles 273-242 (Cont.)					
258R	BW7	noncohesive	250	1.46	BLUE
255R	BW7	noncohesive	350	1.60	BLUE
250L	BW8	noncohesive	700	4.20	BLUE
249R	BW9	cohesive-medium	760	1.06	BLUE
247R	BW9	cohesive-medium	110	4.85	BLUE
246R	BW9	cohesive-medium	130	3.58	BLUE
246L	BW10	cohesive-medium	530	1.98	BLUE
245L	BW11	cohesive-medium	460	0.76	BLUE
244L	BW11	cohesive-medium	460	0.60	BLUE
246L	SEC1	cohesive-medium	530	1.98	BLUE
					(Sheet 7 of 7)

(28.4 cu m/year/m), which is above the level of significance. Therefore, one would expect that this inlet and associated backwater would be colored YELLOW. However, it was colored BLUE instead (Table 13). This is a case where the inspection of the GIS map indicated that due to the angle and location of the inlet relative to the navigation channel, the discharge into the backwater inlet would be small. Therefore, it was concluded that the volume of sediment entering the inlet would be significantly lower than what was indicated using Plate 6.

Generally, inlets of backwaters or secondary channels that were less than 100 m from the middle sailing line and/or had a water depth of less than 1.0 m and/or a cohesive sediment adjacent to the inlet tended to be extrapolated as having a medium potential impact color of YELLOW. As illustrated in the preceding paragraph, there were exceptions to these conditions. However, other data and information that were not obvious supported those exceptions when only these conditions are considered.

Results in Mississippi River nontrend Pools 5 through 25

Pool 5. In Pool 5, BW2 and BW4 were determined to have a medium potential and were colored YELLOW. Both of these backwaters have cohesive-medium sediment adjacent to the inlets and BW2 had a depth less than 1.0 m. BW4 had one inlet with a depth less than 1.0 m and another inlet within 70 m of the sailing line (Table 13). Plate 7 depicts the location of BW2 in Pool 5, and Plate 8 shows BW4 and adjacent BLUE backwaters in Pool 5.

Pool 5A. All backwaters and the one secondary channel in Pool 5A were designated as having negligible impact potentials (BLUE).

Pool 6. In Pool 6, BW1 was determined to have a medium potential for impacts based on the water depth, proximity to the sailing line, and sediment concentrations from the propeller jet. Therefore, this backwater was given an impact color of YELLOW. Plate 9 shows the location of BW1 in Pool 6. It should be noted that this backwater is immediately downstream of Lock and Dam 5A, and the specific way that flow passes through Dam 5A and moves downstream may have an influence on the potential for the sediment that enters the backwater to be removed.

Pool 7. All backwaters and secondary channels in Pool 7 were designated as having negligible potential impacts and were colored BLUE.

Pool 9. In Pool 9 one backwater and one secondary channel were determined to have the potential for medium impacts from towboats and were colored YELLOW. Designation of BW4 as YELLOW was based collectively on the adjacent sediment type, distance to the middle sailing line, and water depth. SEC3 of Pool 9 was determined to have a medium potential based on the distance to the sailing line and propeller jet concentrations. Plate 10 shows BW4 and some of the adjacent backwaters in Pool 9. SEC3 in Pool 9 is shown in Plate 11.

Pool 10. BW10 in Pool 10 was designated as having a medium potential for impacts from towboats (Table 13). This determination was based on the adjacent sediment type, distance to the middle sailing line, and relatively small water depth. Plate 12 illustrates the location of BW10 relative to BW9, BW11, and BW12. All Pool 10 secondary channels were determined to have negligible impacts.

Pool 11. In Pool 11, BW1 and BW3 were determined to have medium potential for impacts from towboats and were given the color YELLOW. BW1 was designated as such due to the distance to the middle sailing line and the NAVSED propeller jet concentration still high at the inlet. BW3 was determined to be YELLOW based on the distance to the sailing line. Plate 13 shows the location of BW1 and BW3 in Pool 11 along with BW2 and BW4, which were designated BLUE.

Pools 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, and 25. Based on the water depth at the inlets and distance from the sailing line, all backwaters and secondary channels in these pools were designated as having negligible impacts from towboat navigation and were colored BLUE (Table 13).

Results in Mississippi River nontrend Pools 1 through 3

The method of extrapolation used on nontrend Pools 1 through 3 was significantly different from that used on the other nontrend pools. A change in the methodology was necessitated by the fact that data for those pools were not available at the time that the Hydraulic Classification was developed. Initial classification was accomplished using Mississippi River Navigation Charts by CHL and the U.S. Army Engineer District, St. Paul. The result of that classification was delineation of backwaters and secondary channels in Pools 2 and 3. Based on the knowledge and experience of the St. Paul District with this portion of the Mississippi River, it was concluded that no backwaters or secondary channels were associated in Pool 1. Additionally, the St. Paul District stated that the bed material in Pool 1 was mainly gravel size or larger. Therefore, it was concluded that any projected increase in traffic in Pool 1 would not have any significant impacts to any areas of Pool 1.

In Pools 2 and 3 the areas identified as backwaters and secondary channels were based on the navigation charts. Bathymetry data available for Pools 2 and 3 were included in various hydrographic surveys from April 1996 to December 1998. The land coverage used was provided by the U. S. Fish and Wildlife Service Environmental Management Technical Center. The Pool 2 land coverage was from 1975, while the Pool 3 land coverage was dated 1989. The St. Paul District collected bed material sediment samples at the inlets identified for each backwater and secondary channel. The samples were obtained in the channel border area immediately adjacent to the inlet and riverward from that point at a water depth of 1.5 m. Those samples were then classified using the method previously used on the other UMRS areas. It should be noted that at some locations the St. Paul District was unable to obtain bed material samples. In those areas a bed material type was assumed based on the bed material data upstream and downstream of that site.

Using the bathymetry data and water surface elevations for low, medium, and high flow conditions on Pools 2 and 3, the limits of the navigation channel based on a water depth of 9 ft (2.7 m) were identified. Using that information the center sailing line was determined. At that time the water depth for the low flow condition at the identified backwater and secondary channel inlets was also determined from the GIS database. It should be noted that the available bathymetry data were somewhat limited in that in most locations the bathymetry of the channel borders was not included. Therefore, when the extrapolation was undertaken the main emphasis was given to the adjacent sediment type and distance to the sailing line. At that point sufficient data were available to make an extrapolation to Pools 2 and 3 using the same procedure as was used on the other Mississippi River nontrend Pools 5 through 25.

Pool 1. As stated, based on available data, it was determined that Pool 1 would not have any potential impacts from increases in navigation traffic.

Pool 2. In Pool 2, 13 backwaters and 6 secondary channels were identified (Table 14). Using the extrapolation procedures described previously, it was determined that BW8 and BW10 had the potential for medium impacts from towboat navigation. Therefore, those backwaters were colored YELLOW (Table 14). This determination was based on medium cohesive sediments being adjacent to the backwater inlet and the distance from the sailing line to the inlet being less than 100 m. Backwaters BW8 and BW10 are shown in Plate 14.

Pool 3. In Pool 3, eight backwaters and one secondary channel were identified. In this pool BW2 and SEC1 were determined to have medium potential for impacts from towboat navigation; therefore, those attributes were colored YELLOW. The basis for this selection was the presence of medium-cohesive bed material adjacent to the inlet and the distance from the sailing line to the inlet being 100 m or less. Backwater BW2 is shown in Plate 15, and SEC1 is shown in Plate 16.

Table 14
Nontrend Pools 1 Through 3, Mississippi River

River Mile	Associated Attribute	Adjacent Sediment	Distance To Sailing Line m	Depth m	Impact Color
Pool 2, River Miles 848-815					
847.2R	BW1	noncohesive	50	3.10	BLUE
834L	BW2	cohesive-medium	190	2.90	BLUE
832R	BW3	no sample, assumed noncohesive	120	8.20	BLUE
832L	BW4	cohesive-medium	130	5.00	BLUE
829.8R	BW5	noncohesive	INLET NONE EXISTENT IN 1975		
829.6L	BW6	cohesive-medium	NO BATHYMETRY DATA		N/A
828.3L	BW6	no sample, assumed cohesive-medium	NO BATHYMETRY DATA		N/A
827.6L	BW7	noncohesive	140	4.20	BLUE
826.6R	BW8	cohesive-medium	INLET NONE EXISTENT IN 1975		
826.2R	BW8	cohesive-medium	50	4.70	YELLOW
824.9L	BW9	noncohesive	240	4.40	BLUE
823.5R	BW10	cohesive-medium	70	4.30	YELLOW
823.4R	BW10	cohesive-medium	115	4.00	BLUE
821.8R	BW11	no sample, assumed cohesive-medium	350	1.50	BLUE
821.8L	BW12	cohesive-medium	120	4.60	BLUE
846.3R	BW13	noncohesive	50	2.80	BLUE
839.5R	SEC1	noncohesive	BATHYMETRY DATA REGISTRATION ERROR		N/A
835.9L	SEC2	noncohesive	230	1.20	BLUE
831.3R	SEC3	noncohesive	150	3.90	BLUE
827.7R	SEC4	cohesive-medium	175	2.30	BLUE
825.8L	SEC5	noncohesive	260	2.00	BLUE
822.7R	SEC6	no sample, assumed cohesive-medium	205	2.20	BLUE
Pool 3, River Miles 815-797					
812.5L	BW1	cohesive-medium	120	1.90	BLUE
808.9R	BW2	cohesive-medium	INLET NONE EXISTENT IN 1989		
808.5R	BW2	cohesive-medium	260	2.30	BLUE
808.4R	BW2	noncohesive	INLET NONE EXISTENT IN 1989		
804.9R	BW2	no sample, assumed cohesive-medium	INLET NONE EXISTENT IN 1989		
803.3R	BW2	noncohesive	INLET NONE EXISTENT IN 1989		
802.8R	BW2	noncohesive	140	3.80	BLUE
802.2R	BW2	noncohesive	INLET NONE EXISTENT IN 1989		
801.8R	BW2	cohesive-medium	85	4.50	YELLOW
802.3L	BW3	noncohesive	235	4.30	BLUE
799.4L	BW4	no sample, assumed cohesive-medium	155	1.60	BLUE
797.3R	BW5	noncohesive	105	4.30	BLUE
800.9R	BW6	cohesive-medium	IMPOUNDED		N/A
799.8R	BW7	cohesive-medium	IMPOUNDED		N/A
799.3R	BW8	cohesive-medium	IMPOUNDED		N/A
811.8R	SEC1	cohesive-medium	100	5.30	YELLOW

Note: No breakwaters or secondary channels are associated with Pool 1. According to the St. Paul District, bed material in Pool 1 is mainly gravel size or larger. Therefore, any increase in towboat traffic should have no impacts in Pool 1.

Illinois Waterway

Results in LaGrange Pool

Table 15 presents the results of the computations for sediment delivered to backwaters and secondary channels on the LaGrange Pool of the Illinois Waterway. For the year 2000, without project, BW2 and BW5 were given a YELLOW designation. That determination was based on sediment delivered to BW2 at the rate of 0.10 cm/year and on the sediment load of 1.04 acre-ft/year (1,282.9 cu m/year) into one of the inlets of BW5. As presented in Table 15, BW6 has a high potential for impacts and was given an impact color of RED based on the sediment delivery rate exceeding 1 cm/year. The sediment delivered into that backwater varies from 1.79 cm/year in the year 2000 without project to a high of 2.24 cm/year with Alternative F in the year 2050. While BW4 had low potential for impacts without project conditions in the year 2000, by the year 2050 for the without-project conditions and for all alternatives, this backwater had medium potential for impacts. Therefore, BW4 initially had a low potential for impacts and was colored BLUE, but subsequently changed to medium potential and was colored YELLOW. This was based on the sediment load exceeding the 1.0-acre-ft/year (1,233.49-cu m/year) level of significance. The LaGrange Pool backwater BW2 is shown in Plate 17, backwater BW4 in Plate 18, and backwaters BW5 and BW6 are depicted in Plate 19. The computations of the LaGrange Pool secondary channels indicated that SEC1 had significant potential for impacts with the sediment loads and sediment rates delivered having very high values for all conditions. Therefore, SEC1 was colored RED. While not to the magnitude of SEC1, significant sediment was delivered to SEC3 and SEC6 also. For SEC3 the sediment rate delivered varied from 0.14 to 0.22 cm/year for year 2000 without project and Alternatives F, K, and L in year 2050, respectively. SEC6 varied from 0.33 to 0.52 cm/year for the same traffic scenarios. Therefore, SEC3 and SEC6 were given the medium impact potential color YELLOW. Plate 20 shows the location of SEC1, Plate 21 shows the location of SEC3, and Plate 22 the location of SEC6 in the LaGrange Pool.

Within the LaGrange Pool the areas were indicated as having significant impact potential based on the discharge into the backwater or secondary channel and proximity to the sailing line. BW5 had discharges into it as high as about 4,100 cfs (116 cu m/sec) and was within about 70 m of the sailing line. At the same time BW6, which was designated with a high potential for impacts (RED), had a maximum discharge of about 2,500 cfs (71 cu m/sec) and was also about 70 m from the sailing line. The difference between the two is that BW6 is much smaller than BW5, 15 acres and 993 acres (6 hectares and 402 hectares), respectively. In the secondary channels SEC3 and SEC6, the high-flow discharge from the TABS-2 was 4,700 cfs (133 cu m/sec) in both locations. In the case of SEC3 there is little water area (10 acres (4 hectares)), which also influenced the sediment delivery rate.

TABLE 15. SEDIMENTS TO BACKWATERS AND SECONDARY CHANNELS, ILLINOIS WATERWAY, LAGRANGE POOL

BASED ON 50% ROLLUP

			WITHOUT PROJECT and ALTERNATIVES B, E, & L						ALTERNATIVE F			ALTERNATIVES J & K		
			YEAR 2000 - 3,955 TOWS			YEAR 2050 - 5,633 TOWS			YEAR 2050 - 6,173 TOWS			YEAR 2050 - 6,124 TOWS		
BW or SEC Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	SEDIMENT LOAD (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	SEDIMENT LOAD (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	SEDIMENT LOAD (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	SEDIMENT LOAD (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
BW1	3437	cohesive-med	0.0002	0.00000	BLUE	0.0003	0.00000	BLUE	0.0003	0.00000	BLUE	0.0003	0.00000	BLUE
BW2	171	noncohesive	0.5750	0.10249	YELLOW	0.8189	0.14596	YELLOW	0.8973	0.15994	YELLOW	0.8897	0.15858	YELLOW
BW3	398	noncohesive	0.0000	0.00000	BLUE	0.0001	0.00000	BLUE	0.0001	0.00000	BLUE	0.0001	0.00000	BLUE
BW4	2080	cohesive-med	0.7909	0.01159	BLUE	1.1266	0.01651	YELLOW	1.2348	0.01809	YELLOW	1.2240	0.01794	YELLOW
BW5	993	cohesive-med	0.5383	0.05258	YELLOW	0.7666	0.07489	YELLOW	0.8402	0.08209	YELLOW	0.8330	0.08138	YELLOW
BW5		cohesive-med	1.0446			1.4878			1.6308			1.6166		
BW5		cohesive-med	0.1302			0.1854			0.2033			0.2015		
BW6	15	cohesive-med	0.7076	1.79139	RED	1.0080	2.04822	RED	1.1048	2.24497	RED	1.0951	2.22522	RED
BW8	179	cohesive-med	0.1740	0.02963	BLUE	0.2478	0.04220	BLUE	0.2716	0.04624	BLUE	0.2692	0.04585	BLUE
SEC1	7	cohesive-med	20.0099	87.1290	RED	28.4928	124.0657	RED	31.2189	135.9360	RED	30.9593	134.80572	RED
SEC2	21	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC3	10	cohesive-med	0.0468	0.14251	YELLOW	0.0666	0.20312	YELLOW	0.0730	0.22266	YELLOW	0.0724	0.22063	YELLOW
SEC5	6	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE
SEC6	69	noncohesive	0.7611	0.33621	YELLOW	1.0841	0.47888	YELLOW	1.1881	0.52484	YELLOW	1.1778	0.52028	YELLOW
SEC7	24	noncohesive	0.0024	0.00302	BLUE	0.0034	0.00431	BLUE	0.0037	0.00472	BLUE	0.0037	0.00468	BLUE
SEC8	16	cohesive-med	0.0016	0.00306	BLUE	0.0023	0.00436	BLUE	0.0025	0.00479	BLUE	0.0025	0.00474	BLUE

Note: To convert acres to square meters, multiply by 4,046.873. To convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] BW7 not included because tributary flows through it. SEC4 not included due to insufficient data.

Extrapolation to Illinois Waterway nontrend pools

The portion of the NAVSED program used on the Illinois Waterway is somewhat different from that used on the pooled portion of the Mississippi River. The main difference is the finer grained material available on the Illinois Waterway, which remains in suspension longer than the coarser material on the Mississippi River. Therefore, as tows move through the Illinois Waterway, some of the bed material resuspended by tows is added to the ambient concentrations. As a result of this resuspension, another parameter that needs to be considered on the Illinois Waterway is the water depth in the navigation channel. That parameter is important because that depth determined the magnitude of the total sediments resuspended by the tow added to the ambient concentration. The shallower navigation channel depths meant that the propeller was closer to the river bottom, which produced higher sediment concentrations.

On the Illinois Waterway the unit volume level of significance parameter was changed from what was used on the Mississippi River pools. A review of Table 16 shows that the annual load per inlet channel width had very few instances where the value was equal to or greater than 0.01 acre-ft/year/m (12.33 cu m/year/m), which was the value used on the Mississippi River. Therefore, on the Illinois Waterway this level of significance was lowered to 0.005 acre-ft/year/m (6.2 cu m/year/m). This approach seemed reasonable due to the finer grained sediments present in the Illinois Waterway. In this way the trend pool quantities computed on the LaGrange Pool of the Illinois Waterway backwaters and secondary channels could be extrapolated to nontrend pools with a higher degree of certainty.

Using the data computed for the backwaters and secondary channels (Table 16), a plot of the Sediment Index (SI) versus the annual load per inlet width was created. The SI is obtained from the NAVSED program and is the total sediment load in the time-history of suspended sediment concentrations that result from the passage of a single tow. Therefore, the units for the SI are (mg/L)-sec. In this instance, the time-history concentration is the addition of sediment to the water column above the ambient due to tow effects and the decay of that concentration over time. That plot showed a good relationship between the SI and annual load per inlet width at least up to values of about 0.017 acre-ft/year/m (20.9 cu m/year/m) (Plate 23). That value is well beyond the value of 0.005 acre-ft/year/m (6.2 cu m/year/m) discussed previously and used to help determine another level of significance for backwaters and secondary channels. Therefore, for the LaGrange Pool, a load of 0.005 acre-ft/year/m (6.2 cu m/year/m) gave an SI of about 11,700 (mg/L)-sec.

Using the SI values computed in the LaGrange Pool at all sections, the depth in the navigation channel along the middle sailing line, and the distance from the middle sailing line to the inlet of the backwater or secondary channel, a family of relationships was developed for the Illinois Waterway (Plate 24). The four relationships were based on navigation channel depths of 4.4, 5.0, 6.0, and 6.7 m. Table 17 presents the SI for the Alton, Peoria, Starved Rock, and Dresden Island and Marseilles Pools. That table was based on the traffic levels for each of those pools. The criteria developed and presented in Table 17 were added to the

Table 16
Worksheet for Extrapolation to Nontrend Pools on the Illinois Waterway, Lagrange Pool, Illinois Waterway

Feature	Actual RM	Sediment Type	MSLD[1] m	Inlet Width m	Sediment Load acre-ft/year	Annual Load/Width acre-ft/m
Backwaters						
BKW01_01	124.5	cohesive-medium	70	50.1	0.0002	0.000004
BKW02_01	121.7	noncohesive	70	200.1	0.5750	0.002874
BKW03_01	114.5	noncohesive	100	14.5	0.0000	0.000000
BKW04_01	113.4	cohesive-medium	80	122.2	0.7909	0.006472
BKW05_01	98	cohesive-medium	70	18	0.1302	0.007233
BKW05_02	95.4	cohesive-medium	70	19.9	1.0446	0.052492
BKW05_03	90.7	cohesive-medium	100	37.3	0.5383	0.014432
BKW06_01	95.2	cohesive-medium	70	75.2	0.7076	0.009410
BKW07_01	HARBOR			114.2		
BKW08_01	82.6	cohesive-medium	80	71.8	0.1740	0.002423
Secondary Channels						
SEC06_01	121.5	noncohesive	90	142	0.7611	0.005360
SEC07_01	87.1	noncohesive	150	146.2	0.0024	0.000017
SEC03_01	140.9	cohesive-medium	100	70.8	0.0468	0.000661
SEC04	INSUFFICENT DATA					
SEC05_01	135.8	noncohesive	90	53.2	0.0000	0.000000
SEC08_01	86	cohesive-medium	280	199.9	0.0016	0.000008

Note: To convert acre-ft to cu m, multiply by 1,233.49.
[1] Distance to the middle sailing line.

Table 17
Data Developed for Extrapolation on the Illinois Waterway Nontrend Pools

SI (mg/L)-sec	Depth at Sailing Line m	Distance Sailing Line To Inlet m
LaGrange and Peoria Pools		
11,700	≥ 6.7	80
11,700	= 6.0	100
11,700	< 5.0	120
Alton Pool		
10,000	≥ 6.7	88
10,000	= 6.0	98
Starved Rock Pool		
15,500	≥ 6.7	70
15,500	= 6.0	90
15,500	< 5.0	118
Marseilles and Dresden Island Pools		
17,500	≥ 6.7	60
17,500	= 6.0	88
17,500	< 5.0	115

method used on the Mississippi River pools for extrapolation of the LaGrange Pool to the nontrend pools on the Illinois Waterway.

Before the extrapolation on the Illinois Waterway was conducted, a table of the backwaters and secondary channels in the nontrend pools was developed (Table 18). This table is very similar to the one developed for the Mississippi River pools, with the exception that an additional column delineating the water depth at the middle sailing line during medium flow conditions was added to Table 18. The distances and depths presented in Table 18 were obtained from the NAVEFF program. Using Table 18, the UMRS GIS database, and the Illinois Waterway navigation charts, each backwater and secondary channel in the Illinois Waterway nontrend pools was evaluated and linked to the LaGrange Pool.

It should be noted that the secondary channels presented in Table 18 have the normal designation SEC followed by a number. Those were delineated in the UMRS GIS database. However, in the Marseilles, Peoria, and Alton Pools there are additional secondary channels designated by the letters SEC followed by a dash and another letter, such as SEC-A. Those secondary channels are not delineated in the database, but they were added as the extrapolation progressed. The addition of these secondary channels produced a more complete analysis for the Illinois Waterway nontrend pools.

Results in Illinois Waterway nontrend pools

Dresden Island Pool. In the Dresden Pool the channel bathymetry was not present; therefore, no depth data were available. However, the inlet to BW2 measured only 48 m from the middle sailing line, and the review of the database and navigation charts indicated that this backwater had a medium potential for impacts from towboat navigation. Therefore, BW2 was given a YELLOW impact color. Plate 25 shows the location of BW2 of the Dresden Island Pool.

Marseilles Pool. All backwaters in the Marseilles Pool were designated as BLUE because all of these backwaters are single-opening backwaters or gravel pits. The secondary channels (SEC1 and SEC-A) were designated as having medium potential for impacts (YELLOW) due to the distances from the middle sailing line to the inlets and the water depth at the sailing line (Table 18). Plate 26 presents SEC1 and Plate 27 shows SEC-A in the Marseilles Pool.

Starved Rock Pool. BW1 and BW2 were designated as having negligible potential for impacts due to the distance from the sailing line to the inlet (for BW1) and alignment of the opening in relationship to the main channel (for BW2). BW3 is listed in Table 18; however, a review of the navigation charts indicated that this backwater is in the impounded portion of the Starved Rock Pool. The two secondary channels of SEC1 and SEC2 were designated as YELLOW due to the distances from the middle sailing line to the inlets and the water depths at the sailing line (Table 18). Secondary channels SEC1 and SEC2 are shown in Plate 28.

Table 18
Extrapolation to Illinois Waterway Nontrend Pools

River Mile	Associated Attribute	Adjacent Sediment	Distance To Sailing Line m	Depth at Inlet m	Depth at Sailing Line m	Impact Color
Dresden Island, River Miles 286-271						
285R	BW1	noncohesive	72	NO DATA AVAILABLE		BLUE
280L	BW2	noncohesive	48	NO DATA AVAILABLE		YELLOW
277R	BW3	noncohesive	94	NO DATA AVAILABLE		BLUE
276R	BW4	noncohesive	233	NO DATA AVAILABLE		BLUE
Marseilles, River Miles 271-247						
265R	BW1	noncohesive	70	0.55	4.6	BLUE
262L	BW2	cohesive-medium	90	1.62	3.7	BLUE
259L	BW3	cohesive-medium	80	0.55	4.4	BLUE
248L	BW4	noncohesive	90	1.46	4.1	BLUE
261R	SEC1	noncohesive	50	1.22	4.0	YELLOW
256R	SEC-A	noncohesive	70	0.40	3.6	YELLOW
Starved Rock, River Miles 247-231						
242R	BW1	noncohesive	100	0.67	4.6	BLUE
236R	BW2	cohesive-medium	60	0.85	4.2	BLUE
234R	BW3	cohesive-medium	IMPOUNDED			NA
239L	SEC1	noncohesive	70	3.60	4.5	YELLOW
236R	SEC2	cohesive-medium	60	0.85	4.2	YELLOW
Peoria, River Miles 231-158						
231L	BW1	noncohesive	50	1.9	4.5	BLUE
226R	BW2	cohesive-medium	100	1.0	5.3	BLUE
223R	BW3	cohesive-medium	CANAL			NA
219R	BW4	noncohesive	80	0.9	4.6	BLUE
215R	BW5	cohesive-medium	70	2.8	4.6	BLUE
213L	BW7	cohesive-soft	110	1.1	4.2	BLUE
211R	BW6	cohesive-medium	140	0.8	4.6	BLUE
210R	BW9	cohesive-medium	130	3.4	7.9	BLUE
209L	BW8	cohesive-soft	130	1.2	4.5	BLUE
201R	BW10	cohesive-medium	100	0.8	4.6	YELLOW
197L	BW11	cohesive-medium	150	0.6	5.9	BLUE
196R	BW12	cohesive-medium	120	0.8	5.4	BLUE
194L	BW13	cohesive-medium	60	0.8	5.2	BLUE
193R	BW14	cohesive-medium	80	0.7	5.5	BLUE
190R	BW14	cohesive-medium	80	0.6	6.2	BLUE
192L	BW15	cohesive-soft	160	0.8	5.7	BLUE
190L	BW15	cohesive-soft	170	0.6	6.2	BLUE
188L	BW17	cohesive-soft	150	0.7	7.2	BLUE
187R	BW16	cohesive-medium	230	1.0	5.9	BLUE
184R	BW18	cohesive-medium	140	0.8	7.1	BLUE
182R	BW19	cohesive-medium	90	1.0	7.5	BLUE
181R	BW20	cohesive-medium	180	0.6	3.9	BLUE
182L	BW21	cohesive-medium	IMPOUNDED			NA
181L	BW21	cohesive-medium	IMPOUNDED			NA
160L	BW22	noncohesive	110	0.6	5.0	BLUE
216L	SEC1	noncohesive	140	1.1	4.2	BLUE
195R	SEC2	cohesive-medium	80	0.7	6.0	YELLOW
208L	SEC-A	cohesive-soft	120	3.0	4.5	YELLOW
204L	SEC-B	cohesive-medium	80	1.3	5.6	YELLOW
203R	SEC-C	cohesive-medium	90	1.6	4.3	YELLOW

(Continued)

Table 18 (Concluded)						
River Mile	Associated Attribute	Adjacent Sediment	Distance To Sailing Line m	Depth at Inlet m	Depth at Sailing Line m	Impact Color
Alton Pool, River Miles 80-1						
71L	BW1	cohesive-medium	100	1.90	6.7	BLUE
28R	BW2	cohesive-medium	90	0.90	6.4	YELLOW
15R	BW3	cohesive-medium	150	1.01	5.3	BLUE
9L	BW4	cohesive-medium	180	1.26	7.4	BLUE
8R	BW5	cohesive-medium	150	0.83	7.4	BLUE
4L	BW6	cohesive-medium	LAKE, not BW			NA
70R	SEC1	cohesive-medium	100	1.77	6.8	BLUE
59L	SEC2	cohesive-medium	160	1.63	5.7	BLUE
50L	SEC3	cohesive-medium	150	1.52	6.1	BLUE
45L	SEC4	noncohesive	110	1.70	5.6	BLUE
43R	SEC5	noncohesive	140	1.54	8.5	BLUE
40R	SEC6	cohesive-medium	100	1.67	5.7	BLUE
20R	SEC7	cohesive-medium	150	0.50	5.3	BLUE
14L	SEC8	cohesive-medium	110	3.95	6.4	BLUE
73L	SEC-A	noncohesive	80	1.93	7.7	BLUE
46R	SEC-B	noncohesive	90	1.53	5.5	YELLOW
40L	SEC-C	cohesive-medium	140	1.67	5.7	BLUE
39L	SEC-D	cohesive-medium	130	1.64	5.0	YELLOW
38R	SEC-E	cohesive-medium	90	1.81	5.0	YELLOW
31L	SEC-F	cohesive-medium	100	0.96	5.2	YELLOW
30L	SEC-G	cohesive-medium	200	0.96	6.3	BLUE

Peoria Pool. In the Peoria Pool BW10 was designated as having a medium potential for impacts (Table 18). Plate 29 shows the location of BW10 of the Peoria Pool. Backwaters BW2, BW4, BW5, BW6, BW7, BW8, BW9, and BW19 are single-opening backwaters, have little sediment entering them, and were colored BLUE. The distances from the middle sailing line to the inlets of BW11, BW12, BW15, BW16, BW17, BW18, BW20, and BW22 were greater than the criteria presented previously; therefore, these eight backwaters were colored BLUE. BW1 is located immediately downstream of Starved Rock Dam, BW3 is actually a canal, and BW21 is part of the impounded pool from Peoria Dam; therefore, these three backwaters were designated as having negligible potential for impacts and were colored BLUE. BW13 was colored BLUE based on the alignment of the inlets to the main channel. BW14 was colored BLUE since the inlets came off a secondary channel and not the main channel. The Peoria Pool secondary channel SEC1 was designated BLUE due to the distance between the middle sailing line and the inlet and the depth at the middle sailing line. The remainder of the secondary channels, SEC2, SEC-A, SEC-B, and SEC-C, were designated as having medium potential for impacts and were colored YELLOW. Plate 30 shows the locations of SEC-A, SEC-B, and SEC-C, while Plate 31 shows the location of SEC2 in the Peoria Pool.

Alton Pool. As shown in Table 18, of the six backwaters in the Alton Pool, only BW2 had a medium potential for impacts from towboat navigation. The distances between the middle sailing line and backwater inlets were 100 m or greater for BW1, BW3, BW4, and BW5; therefore, these backwaters were designated as having negligible potential for impacts and were colored BLUE. Based on the navigation charts, it was determined that BW6 was actually a lake;

therefore, that “backwater” was not evaluated. Plate 32 shows the location of BW2 in the Alton Pool. Of the 15 secondary channels in the Alton Pool, 4 channels (SEC-B, SEC-D, SEC-E, and SEC-F) were determined to have medium potential for impacts from towboat navigation and were colored YELLOW. All of these secondary channels, except SEC-D, were within the criteria for the SI. SEC-D was included because inspection of the navigation chart indicated that the inlet was aligned such that sediment could be diverted into the channel during medium and high flow events. SEC-B is presented in Plate 33, SEC-D and SEC-E are shown in Plate 34, and SEC-F is shown in Plate 35. There were 10 secondary channels with distances between the middle sailing line and channel inlets greater than 100 m, which meant that impacts would be negligible. Therefore, SEC1, SEC2, SEC3, SEC4, SEC5, SEC6, SEC7, SEC8, SEC-C, and SEC-G were colored BLUE. SEC-A was designated as having negligible impacts and was colored BLUE due to the sailing depth of 7.73 m and an inlet depth of nearly 2 m.

Mississippi River Open-River Portion

Open-river reach, miles 31 to 74

The open-river portion of the Mississippi River extends from River Mile 203, just upstream of the confluence of the Missouri and Mississippi Rivers, to River Mile 0.0, at the confluence of the Ohio and Mississippi Rivers. The trend reach of the open-river portion extends from River Mile 31 to 74. Certain important data were somewhat limited on the open-river portion of the Mississippi River. No specific sediment data were available, and general sediment data were obtained from a previous study (Keown, Dardeau, and Causey 1981). Navigation channel bathymetry data were sparse in the channel border areas. Additionally, the open-river portion had numerous dikes (equivalent to wing dams in the upstream pools) along the entire study area. Based on a dike inventory conducted in 1989, there are over 850 dikes in this open-river portion of the Mississippi River (Derrick, Gernand, and Crutchfield 1989). These are emergent dikes for flows less than about midbank stage, which potentially have significant influence on the currents and waves in the channel border areas. Also, the dikes maintain the contracted navigation channel planform such that the navigation channel location remains relatively constant for all flow conditions. Therefore, the criteria developed in the upstream pools, particularly in Pool 26, were used in the open-river trend reach.

As discussed previously, one of the most critical criteria is the distance of the sailing line from the inlet to backwaters and secondary channels. As can be seen in Table 19, all of the inlets to backwaters and secondary channels in the open-river trend reach are 200 to 600 m from the sailing line and the sediments adjacent to those inlets are noncohesive. With these two existing conditions, the impacts to the backwaters and secondary channels were determined to be negligible, and the backwaters and secondary channels were given an impact color of BLUE.

TABLE 19. SEDIMENTS TO BACKWATERS AND SECONDARY CHANNELS, OPEN-RIVER TREND REACH, MISSISSIPPI RIVER

			IMPACT COLOR				
			WITHOUT PROJECT		ALTERNATIVE B	ALTERNATIVE E	ALTERNATIVE F
BW or SEC Number	DISTANCE TO SAILING LINE (meters)	ADJACENT SEDIMENT TYPE	YEAR 2000 - 8,989 TOWS IMPACT COLOR	YEAR 2050 - 12,293 TOWS IMPACT COLOR	YEAR 2050 - 12,563 TOWS IMPACT COLOR	YEAR 2050 - 12,946 TOWS IMPACT COLOR	YEAR 2050 - 13,100 TOWS IMPACT COLOR
BW1	200	noncohesive	BLUE	BLUE	BLUE	BLUE	BLUE
BW2	300	noncohesive	BLUE	BLUE	BLUE	BLUE	BLUE
BW3	350	noncohesive	BLUE	BLUE	BLUE	BLUE	BLUE
BW4	410	noncohesive	BLUE	BLUE	BLUE	BLUE	BLUE
BW5	400	noncohesive	BLUE	BLUE	BLUE	BLUE	BLUE
SEC1	600	noncohesive	BLUE	BLUE	BLUE	BLUE	BLUE
SEC2	300	noncohesive	BLUE	BLUE	BLUE	BLUE	BLUE

			IMPACT COLOR		
			ALTERNATIVE J	ALTERNATIVE K	ALTERNATIVE L
BW or SEC Number	DISTANCE TO SAILING LINE (meters)	ADJACENT SEDIMENT TYPE	YEAR 2050 - 13,167 TOWS IMPACT COLOR	YEAR 2050 - 13,320 TOWS IMPACT COLOR	YEAR 2050 - 13,088 TOWS IMPACT COLOR
BW1	200	noncohesive	BLUE	BLUE	BLUE
BW2	300	noncohesive	BLUE	BLUE	BLUE
BW3	350	noncohesive	BLUE	BLUE	BLUE
BW4	410	noncohesive	BLUE	BLUE	BLUE
BW5	400	noncohesive	BLUE	BLUE	BLUE
SEC1	600	noncohesive	BLUE	BLUE	BLUE
SEC2	300	noncohesive	BLUE	BLUE	BLUE

Results in open-river nontrend reaches

In a review of the backwaters and secondary channels in the pooled portion of the Mississippi River and the LaGrange Pool on the Illinois Waterway, it was observed that no areas with noncohesive material adjacent to the inlet were YELLOW or RED when the distance between the sailing line and inlet was 100 m or greater. The distances from the middle sailing line and the inlet of the backwaters and secondary channels in the nontrend reaches of the open-river portion of the Mississippi River were measured. Those distances are presented in Table 20. As shown in Table 20, the distance from the middle sailing line to the inlets varied from 100 to 500 m, and noncohesive bed material was present in all locations. Therefore, all backwaters and secondary channels in the nontrend reaches were determined to be subject to negligible impacts and were designated using BLUE.

Table 20
Mississippi River Open-River Reaches

River Mile	Associated Attribute	Adjacent Sediment	Distance To Sailing Line, m	Impact Color	Note
Reach 203-172					
201R	BW1	noncohesive	Impounded by Mel Price L&D		
200R	BW2	noncohesive	500	BLUE	CLOSURE DIKE
188R	BW3	noncohesive	500	BLUE	CLOSURE DIKE
Reach 172-140					
168L	BW1	noncohesive	300	BLUE	
148L	BW2	noncohesive	450	BLUE	CLOSURE DIKE
146L	BW3	noncohesive	400	BLUE	CLOSURE DIKE
145L	BW4	noncohesive	200	BLUE	
Reach 140-106					
139L	BW1	noncohesive	250	BLUE	
135L	BW2	noncohesive	450	BLUE	
132R	BW3	noncohesive	400	BLUE	
123L	BW4	noncohesive	500	BLUE	CLOSURE DIKE
120L	BW5	noncohesive	250	BLUE	CLOSURE DIKE
118R	BW6	noncohesive	350	BLUE	
115L	SEC1	noncohesive	250	BLUE	
Reach 106-74					
104R	BW1	noncohesive	250	BLUE	
103L	BW2	noncohesive	425	BLUE	
101L	BW3	noncohesive	550	BLUE	
98R	BW4	noncohesive	500	BLUE	
95R	BW5	noncohesive	100	BLUE	
79R	SEC1	noncohesive	450	BLUE	
Reach 31-1					
27R	BW1	noncohesive	250	BLUE	
25L	BW2	noncohesive	375	BLUE	CLOSURE DIKE
22L	BW3	noncohesive	350	BLUE	CLOSURE DIKE
18R	BW4	noncohesive	375	BLUE	
16R	BW5	noncohesive	350	BLUE	
14R	BW6	noncohesive	375	BLUE	
12R	BW7	noncohesive	250	BLUE	
10L	BW8	noncohesive	250	BLUE	CLOSURE DIKE
8L	BW9	noncohesive	300	BLUE	CLOSURE DIKE
31L	SEC1	noncohesive	250	BLUE	
29R	SEC-A	noncohesive	150	BLUE	
5L	SEC2	noncohesive	300	BLUE	

3 Summary and Conclusions

The results on the Mississippi River from Pool 1 through Pool 26 indicate that potential impacts occur in the pools upstream of Pool 14. Generally these impacts appear to be a function of the relative narrowness of the main channel and at times, close proximity of the navigation channel to backwater or secondary channel inlets. It should be pointed out that the proximity of the navigation channel to the inlet is not the only controlling factor, but it is a major factor.

In reviewing the results of this study it should be taken into account that only the sediment volumes delivered to inlets of backwaters and secondary channels were computed. Also, the volumes and rates of filling computed were only the result of bed material resuspended by towboats. Sediments delivered due to ambient flow, wind, recreational vessels, or flood events are not included in this analysis. Additionally, the fact that median, rather than mean, sediment values were used in determining potential impacts may have an influence on the volume of sediment entering backwaters and secondary channels. Therefore, the areas designated as YELLOW or RED should be considered merely as having the potential for impacts from towboats. The areas that were designated as YELLOW or RED should be reviewed and analyzed geomorphically to determine what has occurred in those areas in the past. This will give a reasonable evaluation of the overall performance of a backwater or secondary channel to carry the input sediments through the area and back to the main river channel. For example, based on the experience of the CHL river engineers involved in the UMRS, it is very likely that virtually all of the sediment loads introduced into most of the secondary channels designated as having medium or high impact potential probably pass directly through the channel, with little or no (even short-term) deposition.

Conversely, sediments introduced into backwaters have the potential for longer retention in those areas. Once the sediments pass through the inlet channels and get into lower velocity areas, they could deposit in that area and form somewhat of a delta where the inlet channel meets the backwater. More than likely, if the sediments do settle out and deposit, they will remain there for an undetermined period of time. It is possible that yearly-normal or above-normal flow events (floods) will resuspend the sediments and move them down the system. There is also the potential for wind waves, recreational vessels, or their waves to resuspend the sediments. However, this study effort does not address the ultimate fate of those deposits. Table 21 summarizes the sediment impact analysis discussed in this report.

Table 21
Summary of Sediment Impact Analysis

Type of Pool	Number of BW	Number of BLUE BW	Number of YELLOW BW	YELLOW/TOTAL %
Mississippi River Pools 1 Through 26				
Trend Pools	34	32	2	6
Nontrend Pools	146	136	10	7
ALL BW	180	168	12	7
Type of Pool	**Number of SEC**	**Number of BLUE SEC**	**Number of YELLOW SEC**	**YELLOW/Total %**
Trend Pools	28	26	2[1]	7
Nontrend Pools	35	33	2	6
ALL SEC	63	59	4	6
ALL BW and SEC	243	227	16	7
Illinois Waterway				
Type of Pool	**Number of BW**	**Number of BLUE BW**	**Number of YELLOW or RED BW**	**YELLOW + RED/TOTAL %**
LaGrange Pool	7	4	3[2]	43
Nontrend Pools	35	32	3	9
ALL BW	42	36	6	14
Type of Pool	**Number of SEC**	**Number of BLUE SEC**	**Number of YELLOW or RED SEC**	**YELLOW + RED/TOTAL %**
LaGrange Pool	7	4	3	43
Nontrend Pools	24	12	12	50
ALL SEC	31	16	15	48
ALL BW and SEC	73	52	21	29
Mississippi River Open-River Reach				
Type of Pool	**Number of BW**	**Number of BLUE BW**	**Number of YELLOW BW**	**YELLOW/TOTAL %**
Trend Reach (Miles 31-74)	5	5	0	0
Nontrend Reaches	27	27	0	0
ALL BW	32	32	0	0
Type of Pool	**Number of SEC**	**Number of BLUE SEC**	**Number of YELLOW SEC**	**YELLOW/TOTAL %**
Trend Reach (Miles 31-74)	2	2	0	0
Nontrend Reaches	5	5	0	0
ALL SEC	7	7	0	0
ALL BW and SEC	39	39	0	0

[1] A third secondary channel (SEC8 in Pool 8) had medium impact potential (YELLOW) for Alternatives K and L.
[2] One backwater (BW4) had medium impact potential (YELLOW in LaGrange Pool) for Year 2050 Without Project and all alternatives.

Members of the NECC and some resource agencies requested that the backwaters and secondary channels identified as having the potential for medium or high impacts be presented using the names associated with those areas from the navigation charts. Table 22 presents the requested information using that method.

Table 22
Impacted Backwaters and Secondary Channels by Navigation Chart Title

Pool No. or Name	BW or SEC No.	River Mile and Side	Impact Color	Navigation Chart Name
Mississippi River				
2	BW8	826.6-RIGHT	YELLOW	River Lake
2	BW10	823.5-RIGHT	YELLOW	Spring Lake
3	BW2	801.8-RIGHT	YELLOW	Brewer Lake
3	SEC1	811.8-RIGHT	YELLOW	Prescott Island
5	BW2	752-RIGHT	YELLOW	Island No. 42 (just upstream of Zumbro River)
5	BW4	747-LEFT	YELLOW	Belvidere Island
6	BW1	728-RIGHT	YELLOW	Black Bird Slough
8	BW2	696-RIGHT	YELLOW	Target Lake and Broken Arrow Slough
8	SEC8	690.5-RIGHT	YELLOW	Lawrence Lake area
9	BW4	671-RIGHT	YELLOW	Big Slough
9	SEC3	671-LEFT	YELLOW	Battle Island
10	BW10	620-RIGHT	YELLOW	Frenchtown Lake
11	BW1	614-LEFT	YELLOW	Island No. 189 and Cassville Slough
11	BW3	612-RIGHT	YELLOW	Goetz Slough
13	BW11	533-LEFT	YELLOW	Mound Island and Dark Slough
13	SEC8	543-RIGHT	YELLOW	Big Soupbone Island
13	SEC12	533-RIGHT	YELLOW	Big Cook Island
Illinois Waterway				
DRESDEN ISLAND	BW2	280-LEFT	YELLOW	Treats Island
MARSEILLE S	SEC1	261-RIGHT	YELLOW	Waupecan Sugar Island
MARSEILLE S	SEC-A	256-RIGHT	YELLOW	Barry Island
STARVED ROCK	SEC1	239-LEFT	YELLOW	Hitt and Mayo Islands
STARVED ROCK	SEC2	236-RIGHT	YELLOW	Sheehan Island
PEORIA	BW10	201- RIGHT	YELLOW	Spring Lake
PEORIA	SEC2	195-RIGHT	YELLOW	“gravel pit”
PEORIA	SEC-A	208-LEFT	YELLOW	Hennepin Island
PEORIA	SEC-B	204-LEFT	YELLOW	Upper Twin Sisters Island
PEORIA	SEC-C	203-RIGHT	YELLOW	Lower Twin Sisters Island
LAGRANGE	BW2	123-LEFT	YELLOW	Lower portion of Quiver Lake
LAGRANGE	BW4	113-LEFT	YELLOW	Grand Island
LAGRANGE	BW5	96-LEFT	YELLOW	Sangamon Bay
LAGRANGE	BW6	95-LEFT	RED	Sugar Creek Island
LAGRANGE	SEC1	149-RIGHT	RED	Turkey Island
LAGRANGE	SEC3	140-LEFT	YELLOW	Coon Hollow Island
LAGRANGE	SEC6	122-LEFT	YELLOW	Quiver Island
ALTON	BW2	28-RIGHT	YELLOW	Hurricane and Diamond Islands
ALTON	SEC-B	46-RIGHT	YELLOW	Buckhorn Island
ALTON	SEC-D	39-LEFT	YELLOW	Fisher Island
ALTON	SEC-E	38-RIGHT	YELLOW	Twin Islands
ALTON	SEC-F	31-LEFT	YELLOW	Willow Island

The backwaters and secondary channels designated as having YELLOW or RED impact potentials could be considered for mitigation considerations, if it is determined that geomorphically those areas have been conducive to deposition in the past. In areas where the sediment input potential is due to the close proximity of the inlet to the navigation channel, perhaps the navigation channel can be moved riverward and away from the inlet. In areas where the potential is high due to relatively large discharges into backwaters or secondary channels, perhaps some type of structure could be constructed in the inlet channel to limit the volume of water, and consequently the sediment volume, entering the area.

References

Bhowmik, N. G., Soong, D., Adams, J. R., Xia, R., and Mazumder, B. S. (1996). "Physical changes associated with navigation traffic on the Illinois and Upper Mississippi Rivers," Illinois State Water Survey, Champaign, IL.

Copeland, R. R., Abraham, D. D., Nail, G. H., Seal, R., and Brown, G. L. (2001). "Entrainment and transport of sediments by towboats in the Upper Mississippi River and Illinois Waterway, Numerical model study," ENV Report 37, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Currie, I. G. (1974). *Fundamental mechanics of fluids*. McGraw-Hill, New York, 189-192.

Derrick, D. L., Gernand, H. W., and Crutchfield, J. P. (1989). "Inventory of river training structures in shallow-draft waterways," Technical Report REMR-HY-6, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Fagerburg, T. L., and Pratt, T. C. (1998). "Upper Mississippi River navigation and sedimentation field data collection summary report," ENV Report 6, prepared for U.S. Army Engineer Districts, Rock Island, St. Louis, and St. Paul, by U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Keown, M. P., Dardeau, E. A., and Causey, E. M. (1981). "Characterization of the suspended-sediment regime and bed-material gradation of the Mississippi River Basin," Potamology Program (P-1), Report 1, Volume 1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Maynord, S. T. (1996). "Return velocity and drawdown in navigable waterways," Technical Report HL-96-7, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Maynord, S. T. (1999). "Comparison of NAVEFF model to field return velocity and drawdown data," ENV Report 14, prepared for U.S. Army Engineer Districts, Rock Island, St. Louis, and St. Paul, by U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Nickles, C. R., and Pokrefke, T. J. (2000). "Definitions, boundary delineations, measurements of attributes, and analysis of the hydraulic classification of aquatic areas, Upper Mississippi River System," ENV Report 27, prepared for U.S. Army Engineer Districts, Rock Island, St. Louis, and St. Paul, by U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Parchure, T. M., McAnally, W. H., and Teeter, A. M. (2000) "Wave-induced sediment resuspension near the shorelines of the Upper Mississippi River system," ENV Report 20, prepared for U.S. Army Engineer Districts, Rock Island, St. Louis, and St. Paul, by U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Simons, D. B., Li, Ruh-Ming, Chen, Y. H., Ellis, S. S., and Chang, T. P. (1981). "Investigation of effects of navigation development and maintenance activities of hydrologic, hydraulic and geomorphic characteristics," Working Paper 1 for Task D, Simons, Li & Associates, Inc., Fort Collins, CO.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
August 2003

2. REPORT TYPE
Final report

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
Tow-Induced Backwater and Secondary Channel Sedimentation, Upper Mississippi River System

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Thomas J. Pokrefke, Jr., R. Charlie Berger, Joon P. Rhee, Stephen T. Maynord

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Research and Development Center
Coastal and Hydraulics Laboratory
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Engineer District, Rock Island
Clock Tower Building, P.O. Box 2004, Rock Island, IL 61204-2004;
U.S. Army Engineer District, St. Louis
1222 Spruce Street, St. Louis, MO 63103-2833;
U.S. Army Engineer District, St. Paul
190 5th Street East, St. Paul, MN 55101-1638

10. SPONSOR/MONITOR'S ACRONYM(S)
ENV Report 41

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The work reported herein was conducted as part of the Upper Mississippi River – Illinois Waterway (UMR-IWW) System Navigation Study. The information generated for this interim effort will be considered as part of the plan formulation process for the System Navigation Study.

The UMR-IWW System Navigation Study is being conducted by the U.S. Army Engineer Districts, Rock Island, St. Louis, and St. Paul, under the authority of Section 216 of the Flood Control Act of 1970. Commercial navigation traffic is increasing and, in consideration of existing system lock constraints, will result in traffic delays that will continue to grow into the future. The System Navigation Study scope is to examine the feasibility of navigation improvements to the Upper Mississippi River and Illinois Waterway to reduce delays to commercial navigation traffic. The study will determine the location and appropriate sequencing of potential navigation improvements on the system, prioritizing the improvements for the 50-year planning horizon from the year 2000 to 2050. The final product of the System Navigation Study is a Feasibility Report, including the decision documents for processing to Congress.

One of the concerns possibly associated with potential improvement plans is the determination of sediments introduced to back-waters and secondary channels from towboat navigation. Specifically, the volume of sediments entering backwaters and secondary
(Continued)

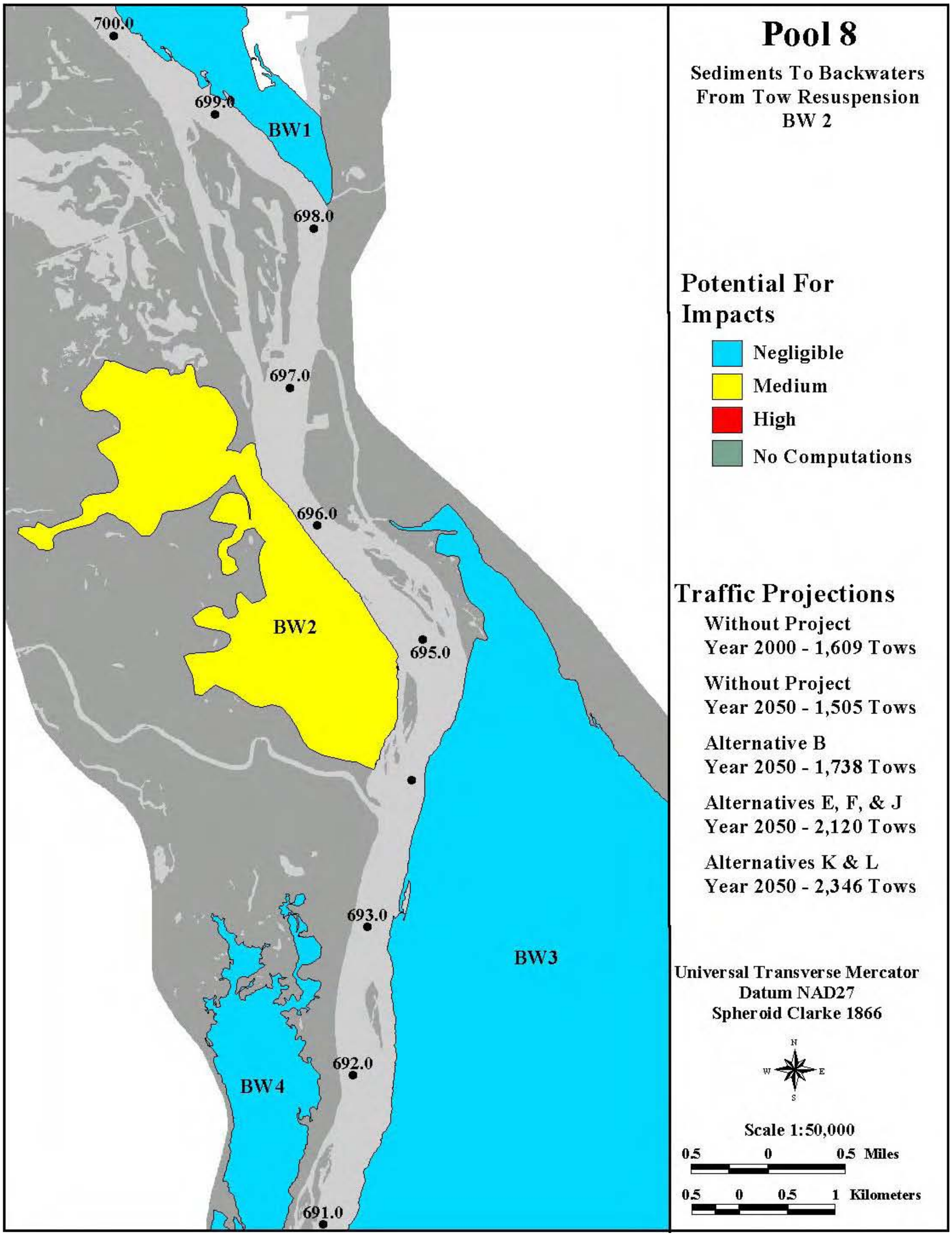
15. SUBJECT TERMS
Backwaters
Navigation
Potential impacts
Secondary channels
Sediment type
Sedimentation
Tow-Induced
UMR-IWW system

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		131	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18

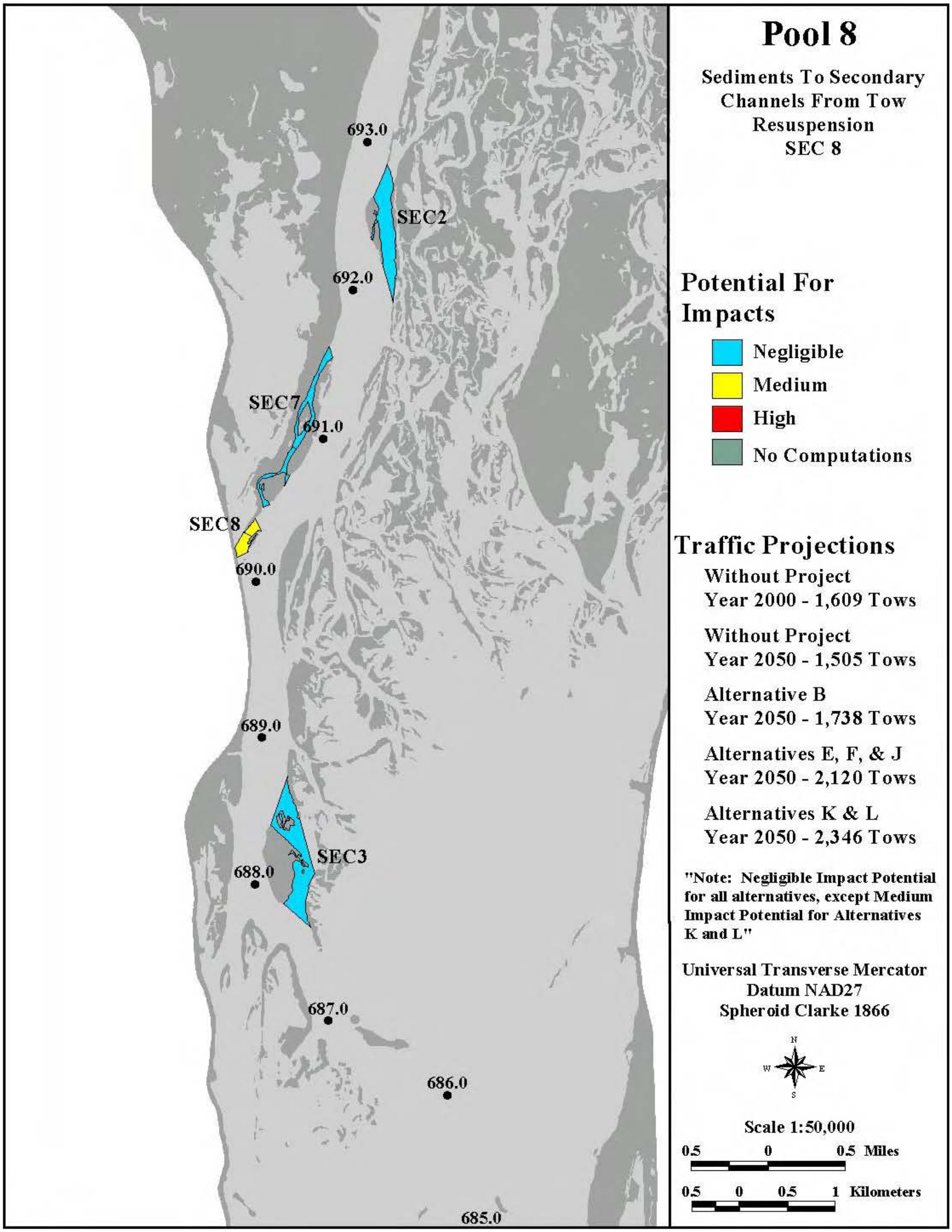
14. (Concluded)

channels in Mississippi River trend pools (Pools 4, 8, 13, and 26), in the open-river trend reach (River Miles 31 to 74), and in the LaGrange Pool on the Illinois Waterway needed to be quantified. After that was accomplished, linkages were to be developed to take the quantified impacts from the trend pools (reach) where significant data are available to the nontrend pools where data were less intensive. These linkages provide extrapolated impacts to the nontrend pools and information to be used to evaluate system impacts and potential mitigation guidance where necessary. The part of the study reported herein determined only how much sediment is delivered to the backwaters and secondary channels of the specified inlets, and computations and resulting sedimentation quantities are the result only of towboat navigation resuspending the channel bed material. As this study effort progressed, it was determined that computing the delivery rates and potential for impacts for base and alternative conditions provided a logical approach for use in addressing backwater and secondary channel sedimentation trends as a result of towboat navigation.



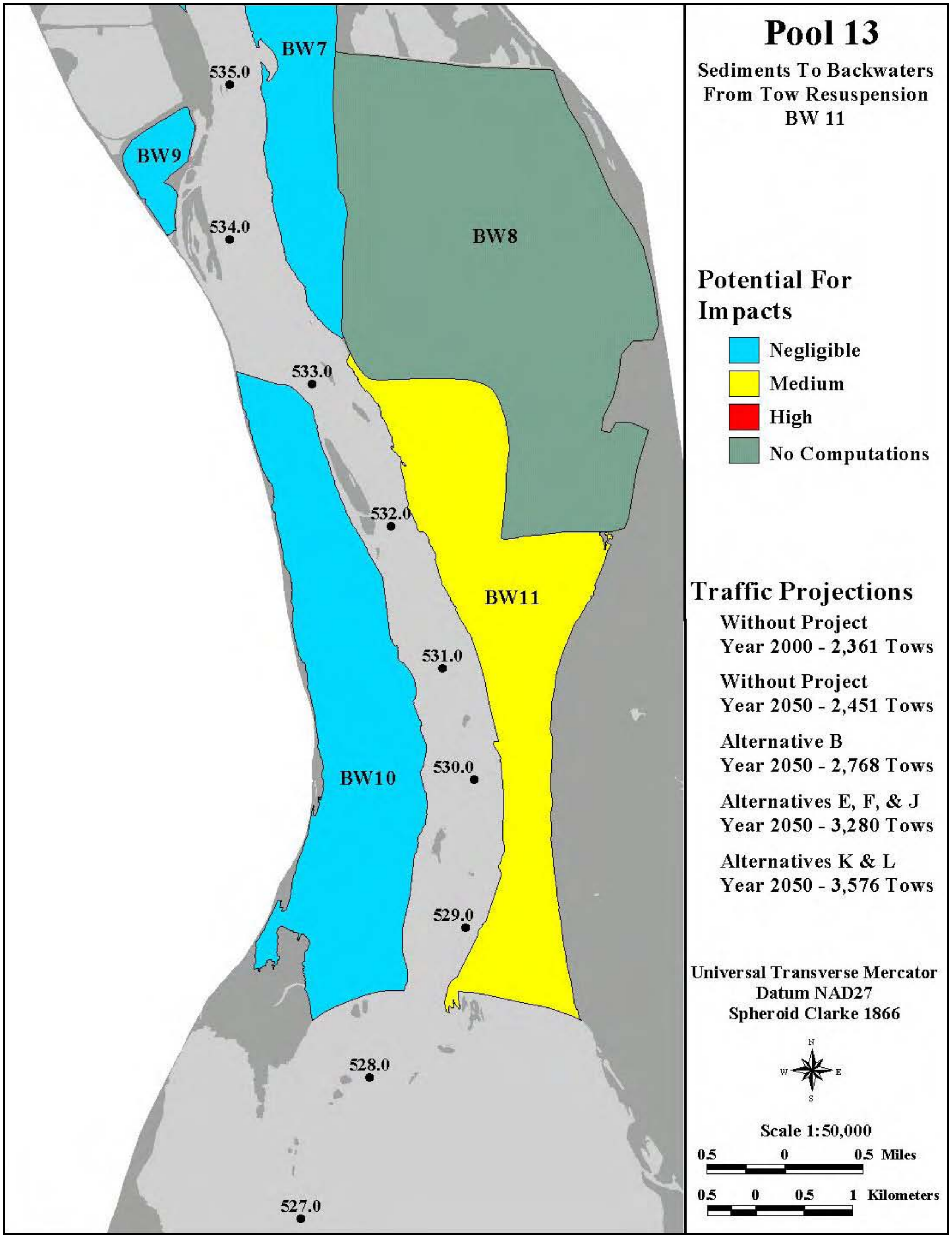
Pool 8
Sediments To Backwaters
From Tow Resuspension
BW 2
Potential For Impacts
Negligible
Medium
High
No Computations
Traffic Projections
Without Project
Year 2000 - 1,609 Tows
Without Project
Year 2050 - 1,505 Tows
Alternative B
Year 2050 - 1,738 Tows
Alternatives E, F, & J
Year 2050 - 2,120 Tows
Alternatives K & L
Year 2050 - 2,346 Tows
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
700.0
699.0
BW1
698.0
697.0
696.0
BW2
695.0
693.0
BW3
692.0
BW4
691.0

Plate 1



693.0
SEC2
692.0
SEC7
691.0
SEC8
690.0
689.0
SEC3
688.0
687.0
686.0
685.0
Pool 8
Sediments To Secondary Channels From Tow Resuspension
SEC 8
Potential For Impacts
Negligible
Medium
High
No Computations
Traffic Projections
Without Project
Year 2000 - 1,609 Tows
Without Project
Year 2050 - 1,505 Tows
Alternative B
Year 2050 - 1,738 Tows
Alternatives E, F, & J
Year 2050 - 2,120 Tows
Alternatives K & L
Year 2050 - 2,346 Tows
"Note: Negligible Impact Potential for all alternatives, except Medium Impact Potential for Alternatives K and L"
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 2



Pool 13
Sediments To Backwaters
From Tow Resuspension
BW 11
Potential For Impacts
Negligible
Medium
High
No Computations
Traffic Projections
Without Project
Year 2000 - 2,361 Tows
Without Project
Year 2050 - 2,451 Tows
Alternative B
Year 2050 - 2,768 Tows
Alternatives E, F, & J
Year 2050 - 3,280 Tows
Alternatives K & L
Year 2050 - 3,576 Tows
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
BW7
BW8
BW9
BW10
BW11
535.0
534.0
533.0
532.0
531.0
530.0
529.0
528.0
527.0

Plate 3

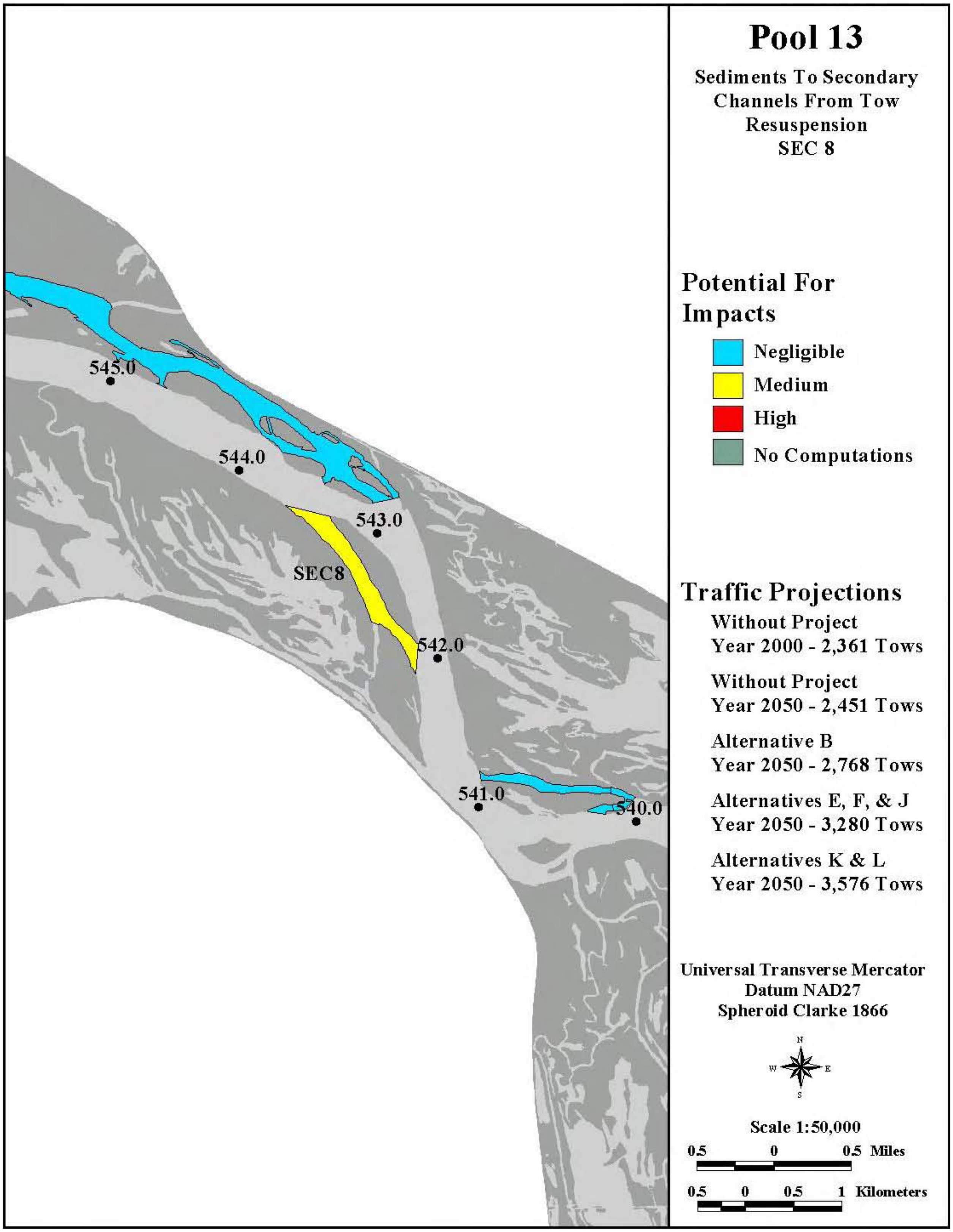
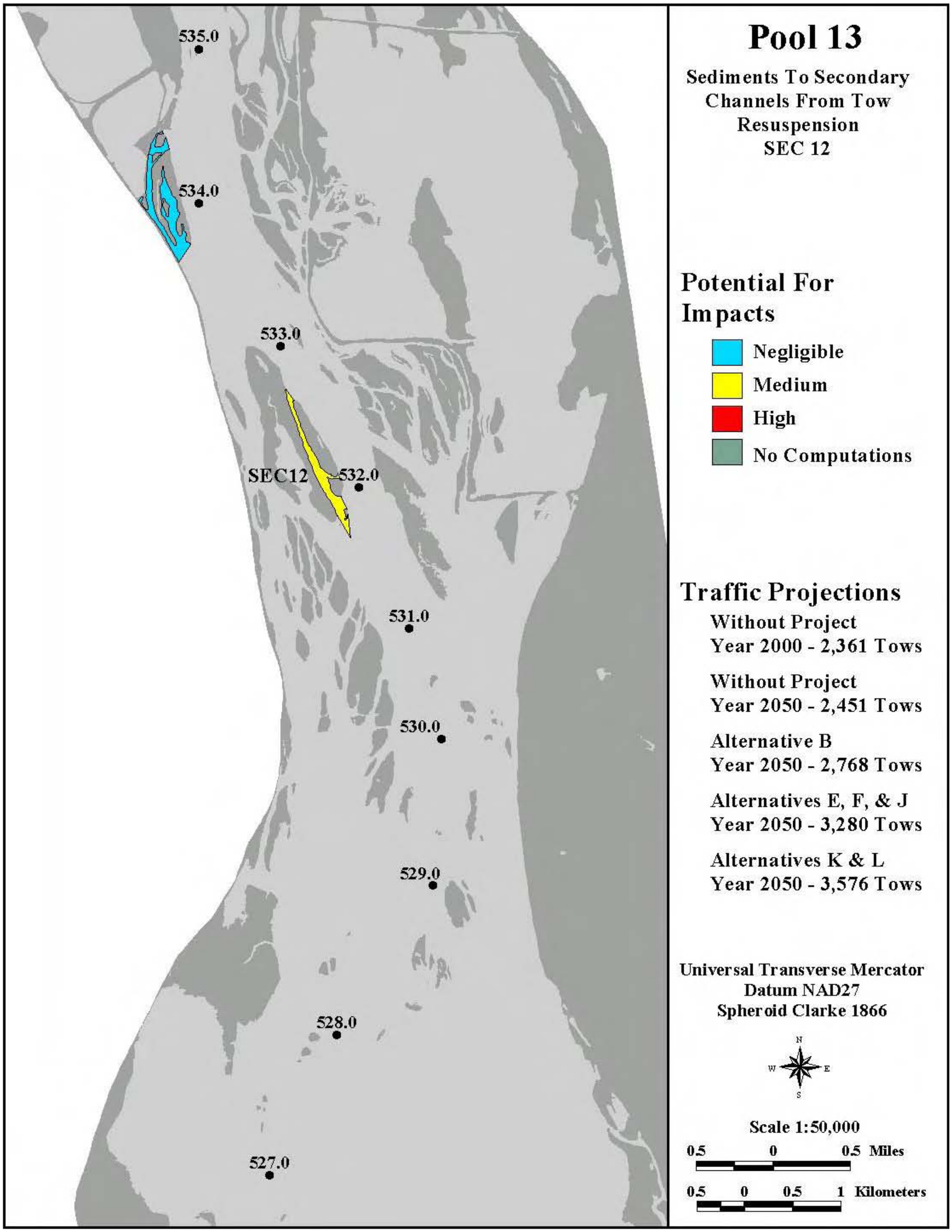

Pool 13
Sediments To Secondary Channels From Tow Resuspension
SEC 8
Potential For Impacts
Negligible
Medium
High
No Computations
Traffic Projections
Without Project
Year 2000 - 2,361 Tows
Without Project
Year 2050 - 2,451 Tows
Alternative B
Year 2050 - 2,768 Tows
Alternatives E, F, & J
Year 2050 - 3,280 Tows
Alternatives K & L
Year 2050 - 3,576 Tows
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
545.0
544.0
543.0
SEC8
542.0
541.0
540.0

Plate 4


Pool 13
Sediments To Secondary Channels From Tow Resuspension
SEC 12
Potential For Impacts
Negligible
Medium
High
No Computations
Traffic Projections
Without Project
Year 2000 - 2,361 Tows
Without Project
Year 2050 - 2,451 Tows
Alternative B
Year 2050 - 2,768 Tows
Alternatives E, F, & J
Year 2050 - 3,280 Tows
Alternatives K & L
Year 2050 - 3,576 Tows
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
535.0
534.0
533.0
SEC12
532.0
531.0
530.0
529.0
528.0
527.0

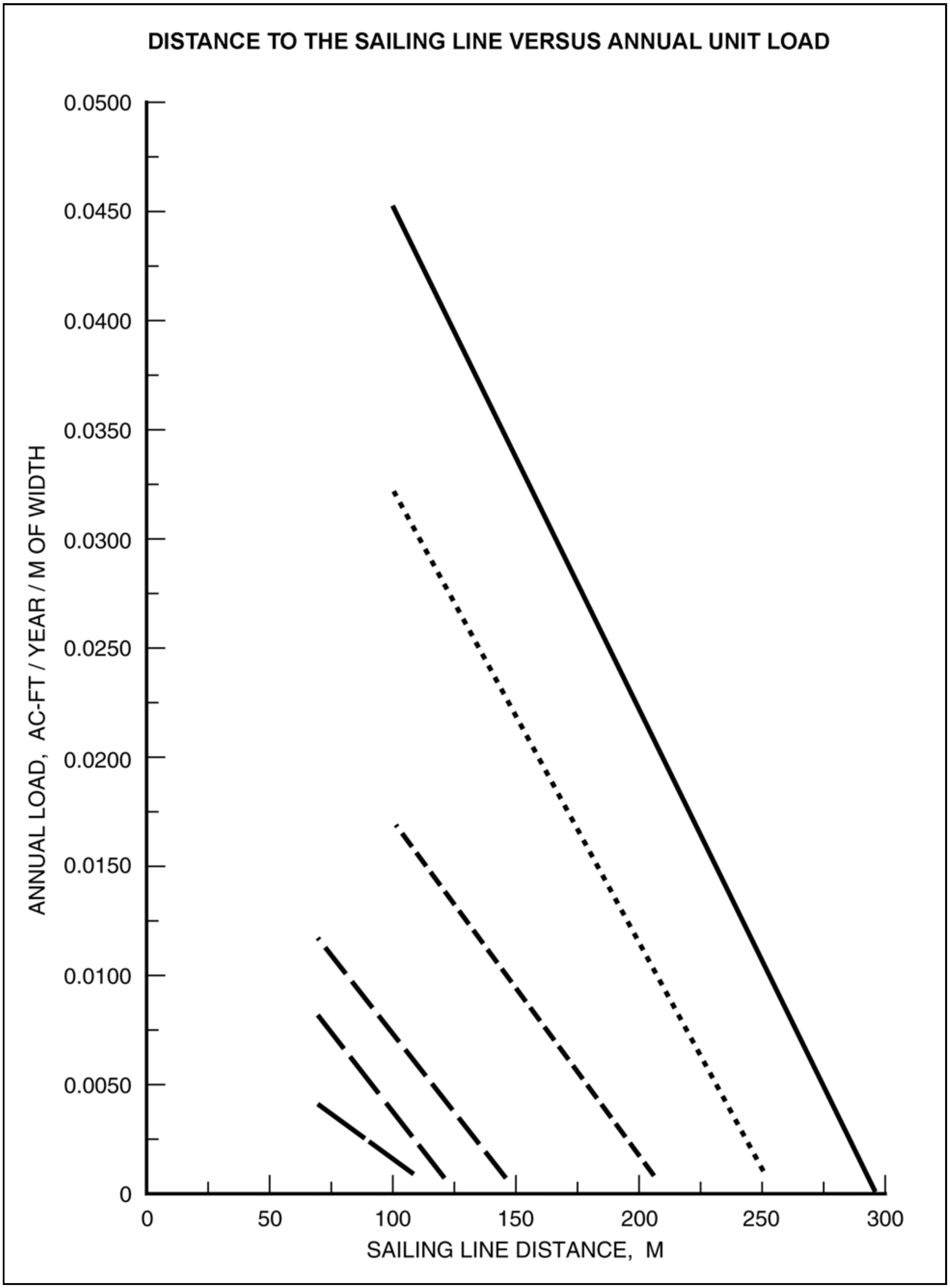
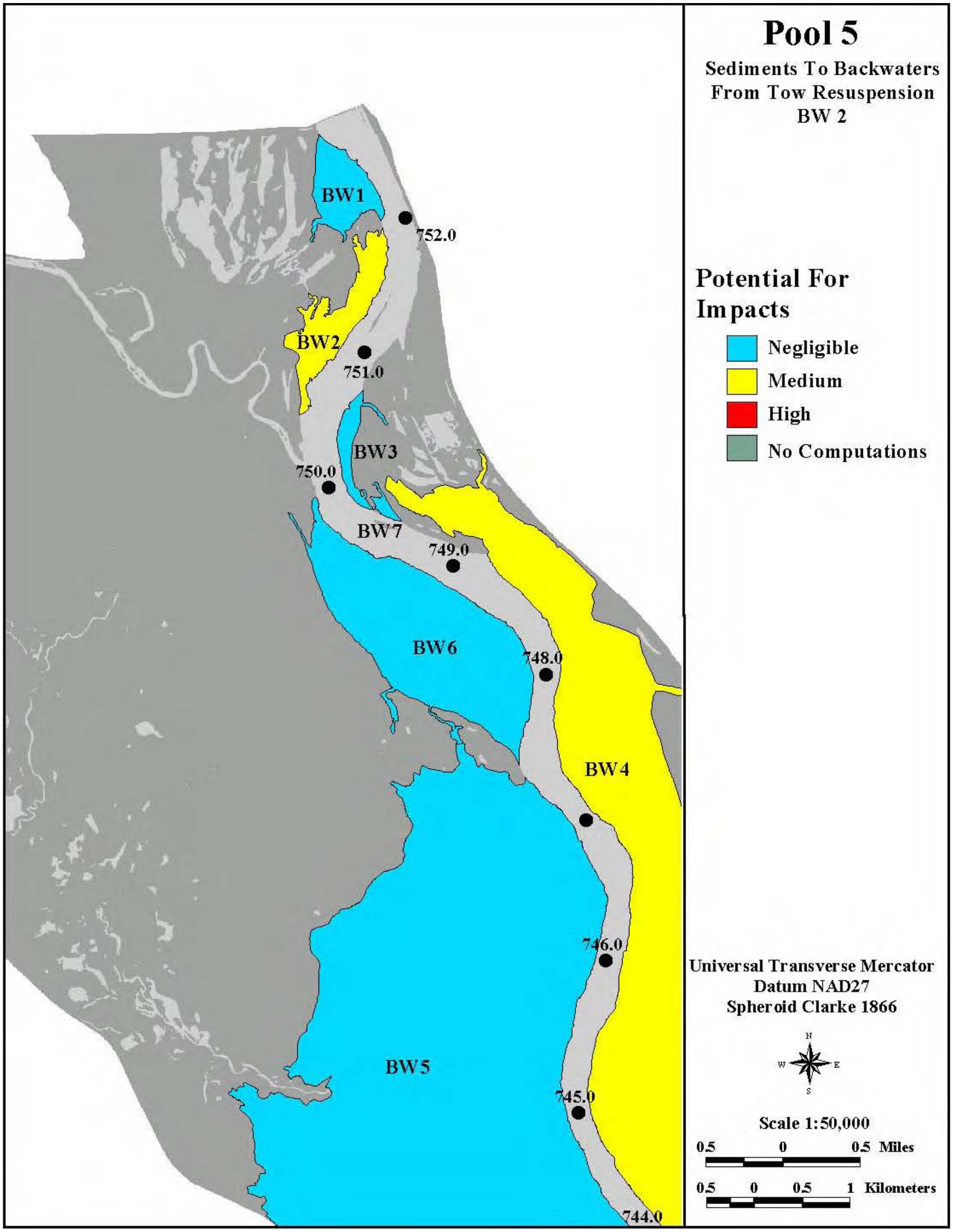
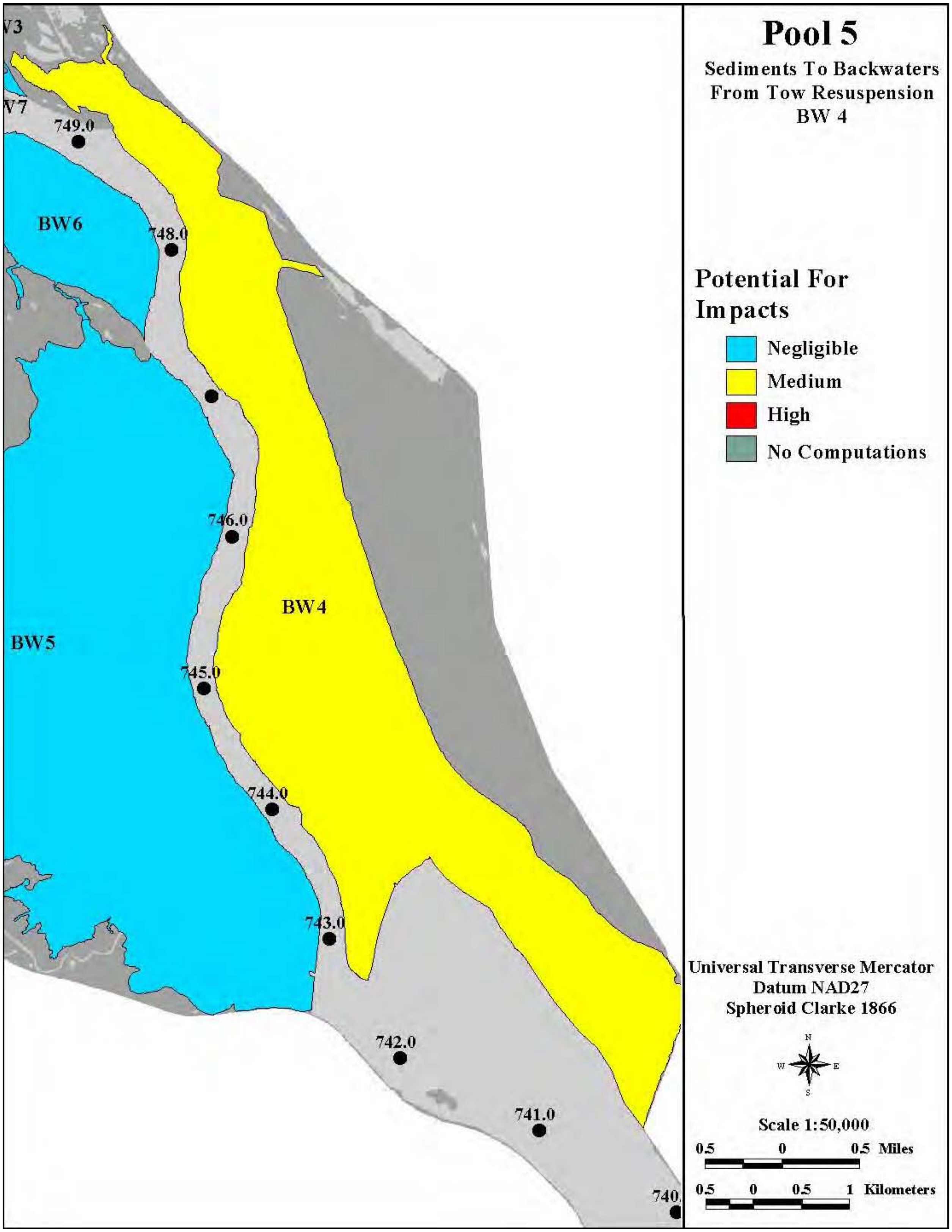

DISTANCE TO THE SAILING LINE VERSUS ANNUAL UNIT LOAD
ANNUAL LOAD, AC-FT / YEAR / M OF WIDTH
0.0500
0.0450
0.0400
0.0350
0.0300
0.0250
0.0200
0.0150
0.0100
0.0050
0
0
50
100
150
200
250
300
SAILING LINE DISTANCE, M

Plate 6


Pool 5
Sediments To Backwaters
From Tow Resuspension
BW 2
Potential For
Impacts
Negligible
Medium
High
No Computations
BW1
BW2
BW3
BW4
BW5
BW6
BW7
752.0
751.0
750.0
749.0
748.0
746.0
745.0
744.0
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers



Pool 5
Sediments To Backwaters
From Tow Resuspension
BW 4
Potential For Impacts
Negligible
Medium
High
No Computations
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
BW6
BW5
BW4
749.0
748.0
746.0
745.0
744.0
743.0
742.0
741.0

Plate 8

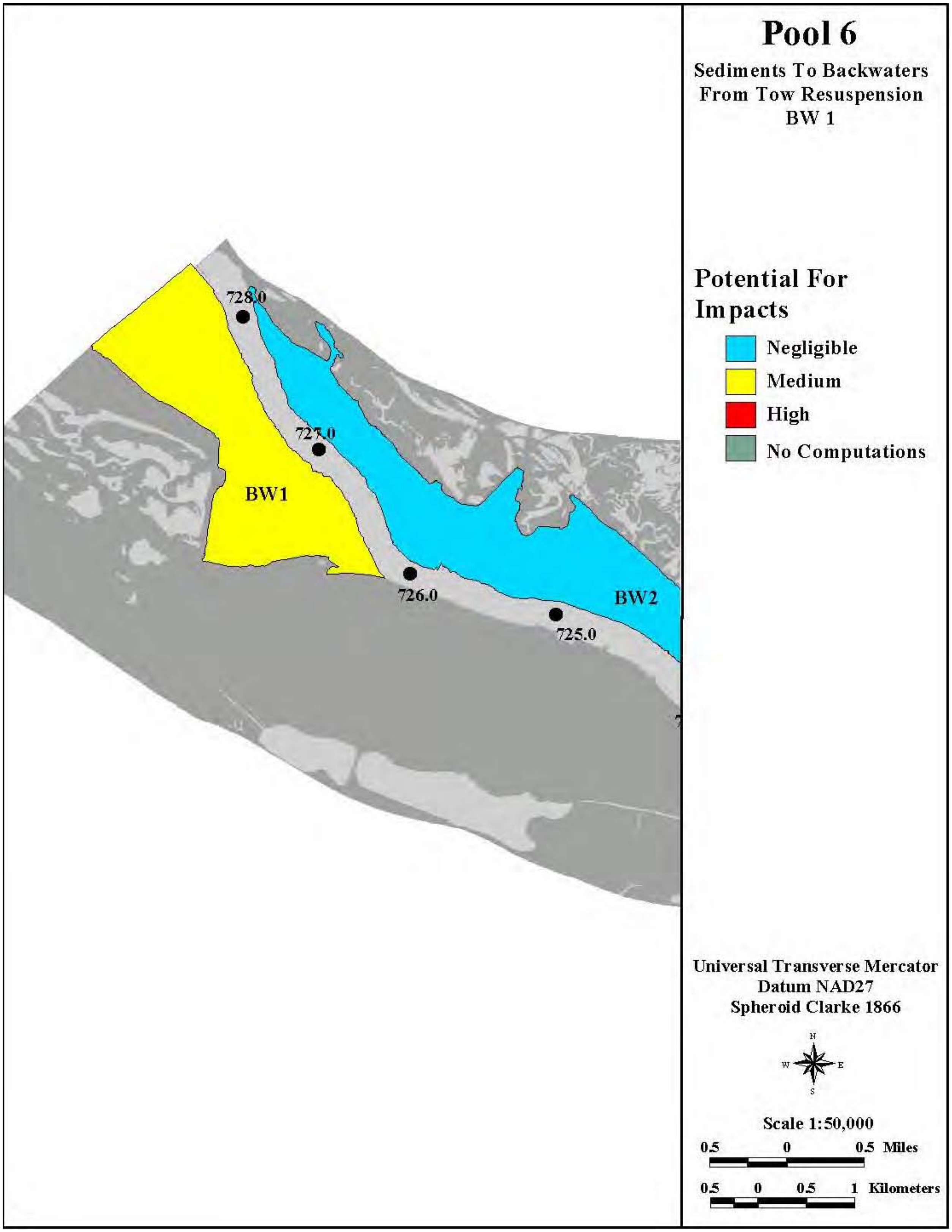
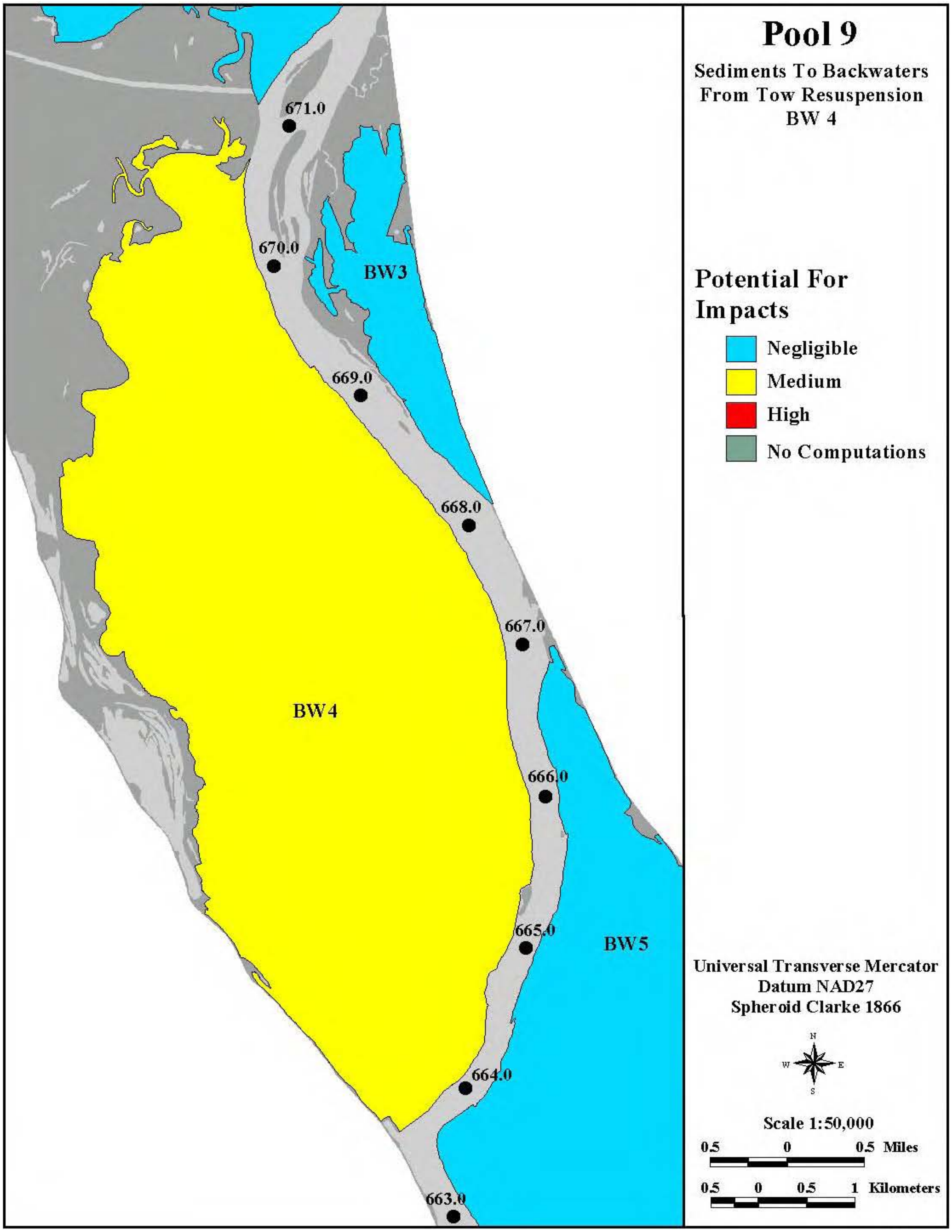

Pool 6
Sediments To Backwaters
From Tow Resuspension
BW 1
Potential For Impacts
Negligible
Medium
High
No Computations
728.0
727.0
726.0
725.0
BW1
BW2
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 9



Pool 9
Sediments To Backwaters
From Tow Resuspension
BW 4
Potential For Impacts
Negligible
Medium
High
No Computations
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
671.0
670.0
669.0
668.0
667.0
666.0
665.0
664.0
663.0
BW3
BW4
BW5

Plate 10

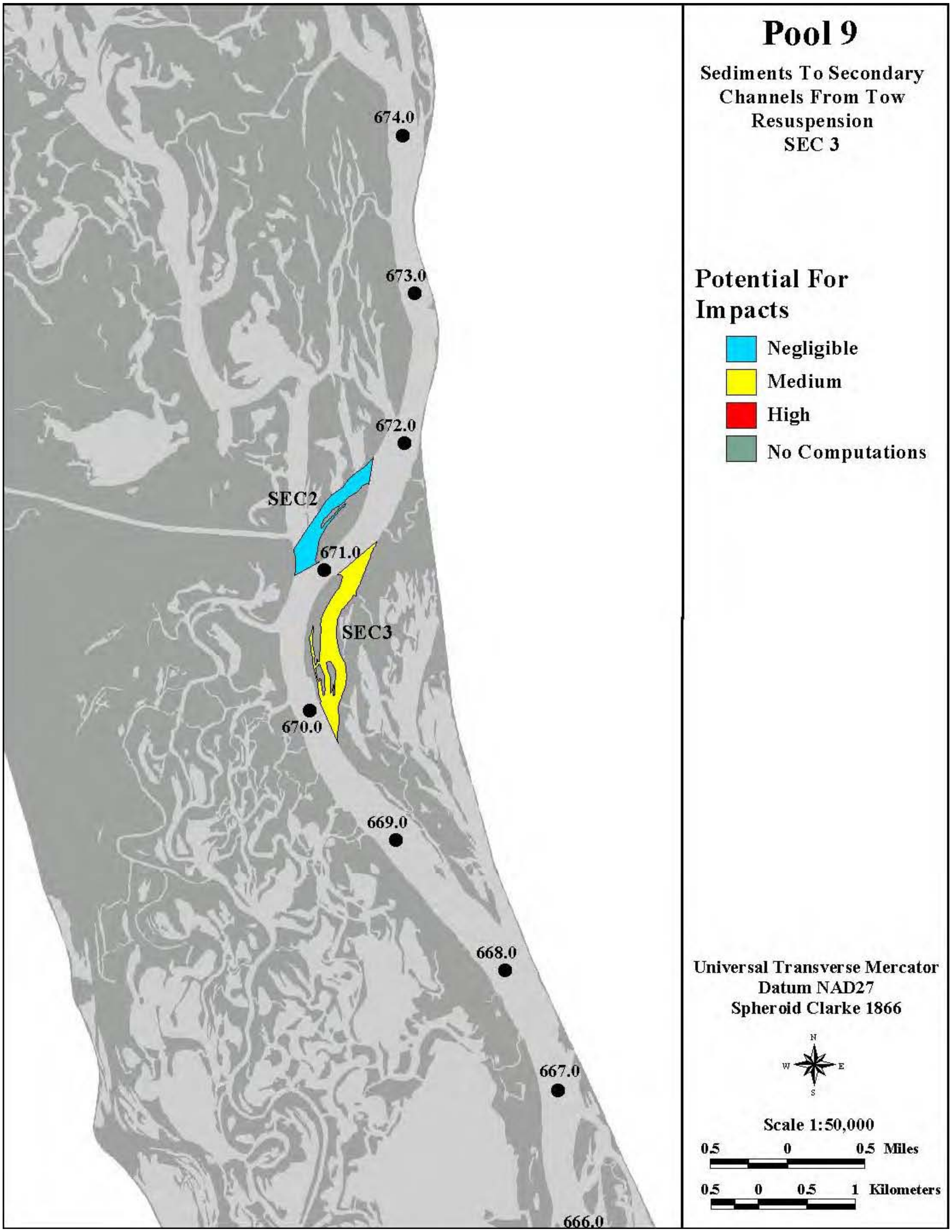
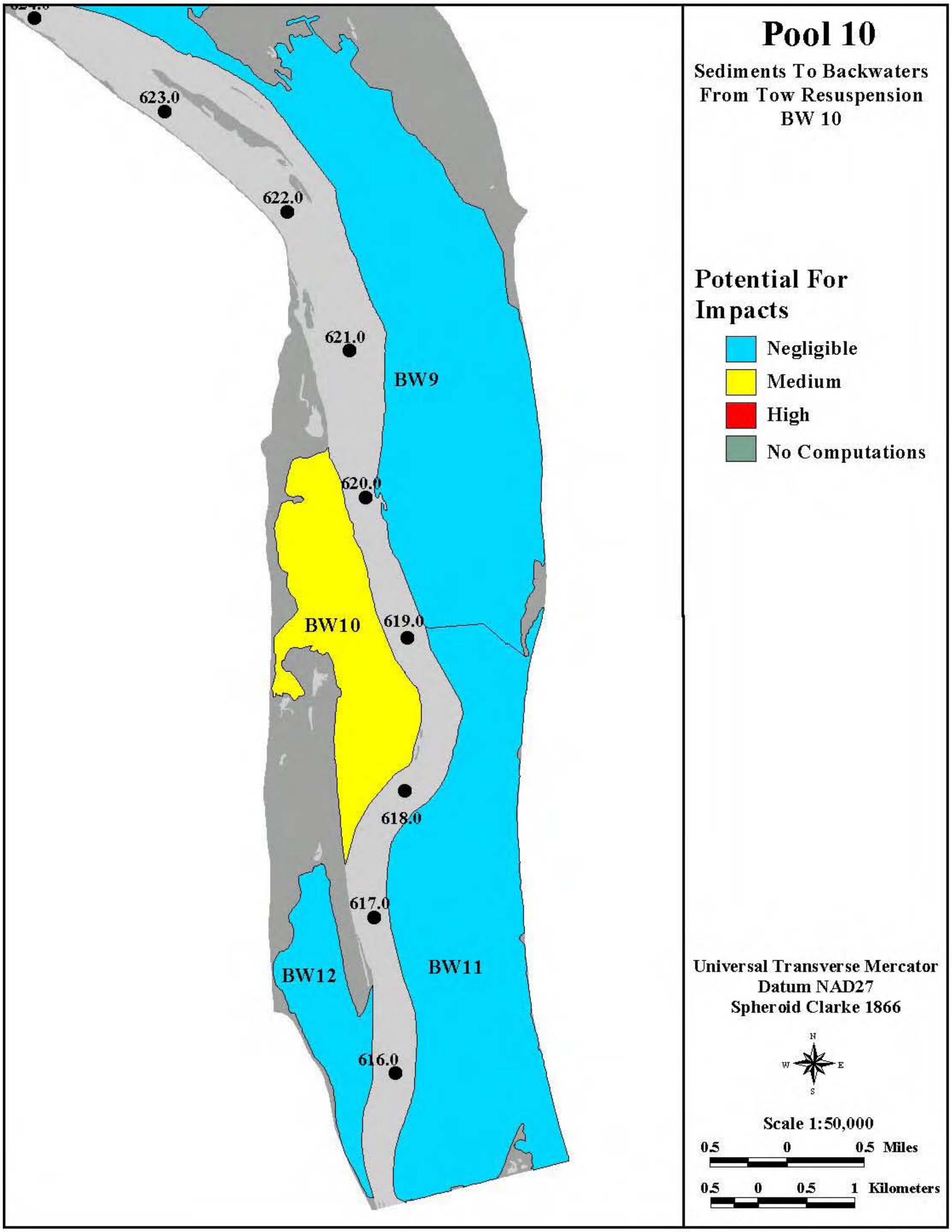
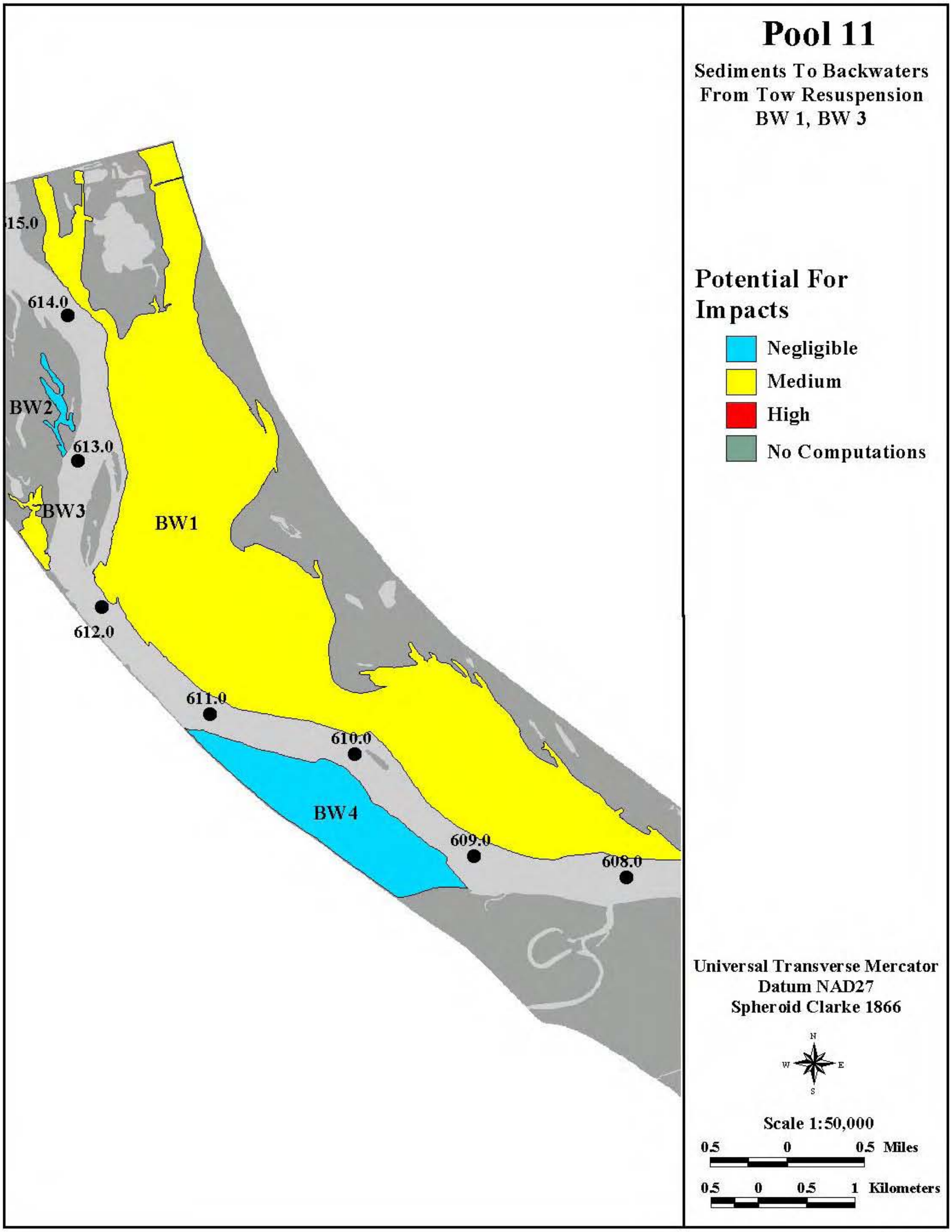

Pool 9
Sediments To Secondary Channels From Tow Resuspension
SEC 3
Potential For Impacts
Negligible
Medium
High
No Computations
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
674.0
673.0
672.0
SEC2
671.0
SEC3
670.0
669.0
668.0
667.0
666.0

Plate 11



623.0
622.0
621.0
BW9
620.0
BW10
619.0
618.0
617.0
BW12
BW11
616.0
Pool 10
Sediments To Backwaters
From Tow Resuspension
BW 10
Potential For Impacts
Negligible
Medium
High
No Computations
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 12


Pool 11
Sediments To Backwaters
From Tow Resuspension
BW 1, BW 3
Potential For
Impacts
Negligible
Medium
High
No Computations
615.0
614.0
613.0
612.0
611.0
610.0
609.0
608.0
BW1
BW2
BW3
BW4
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

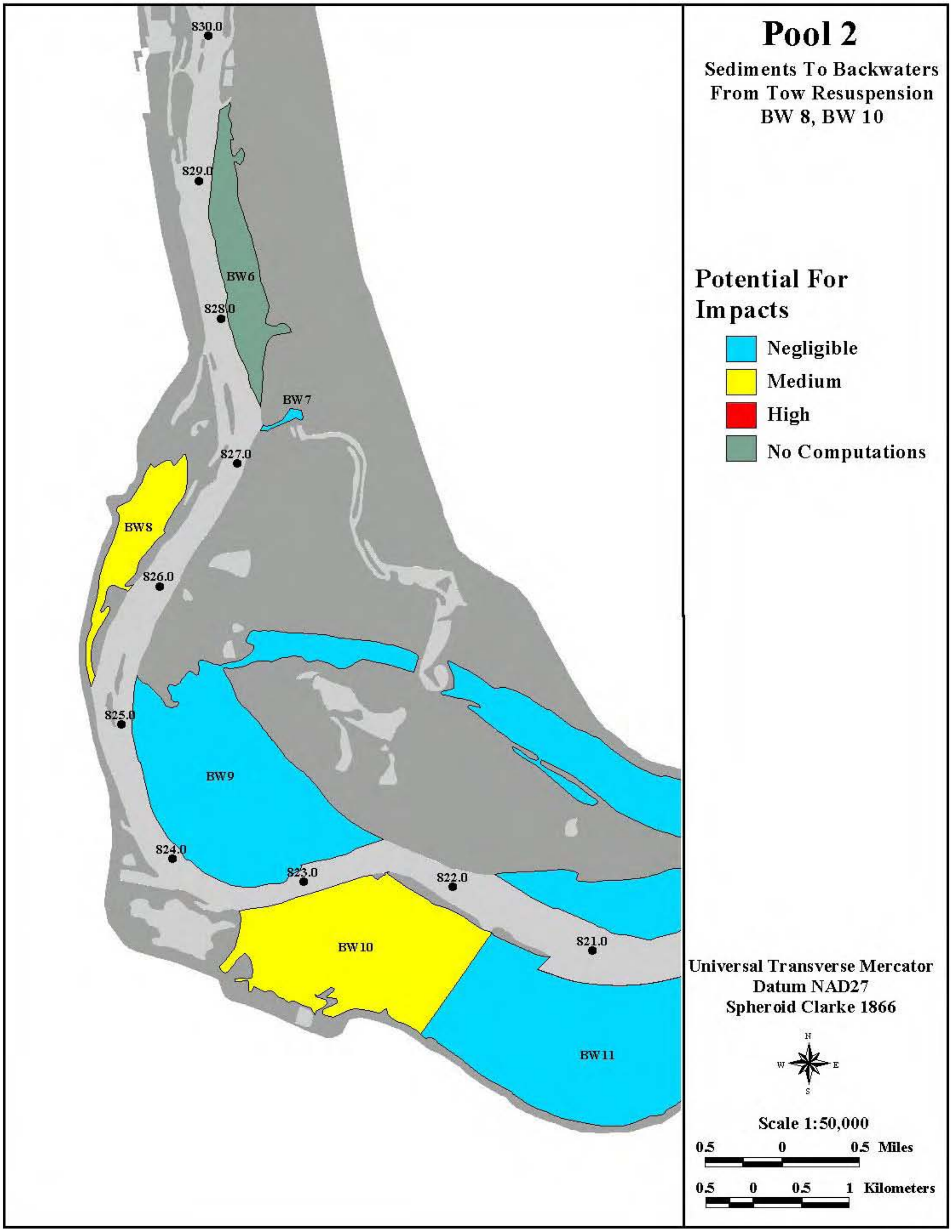
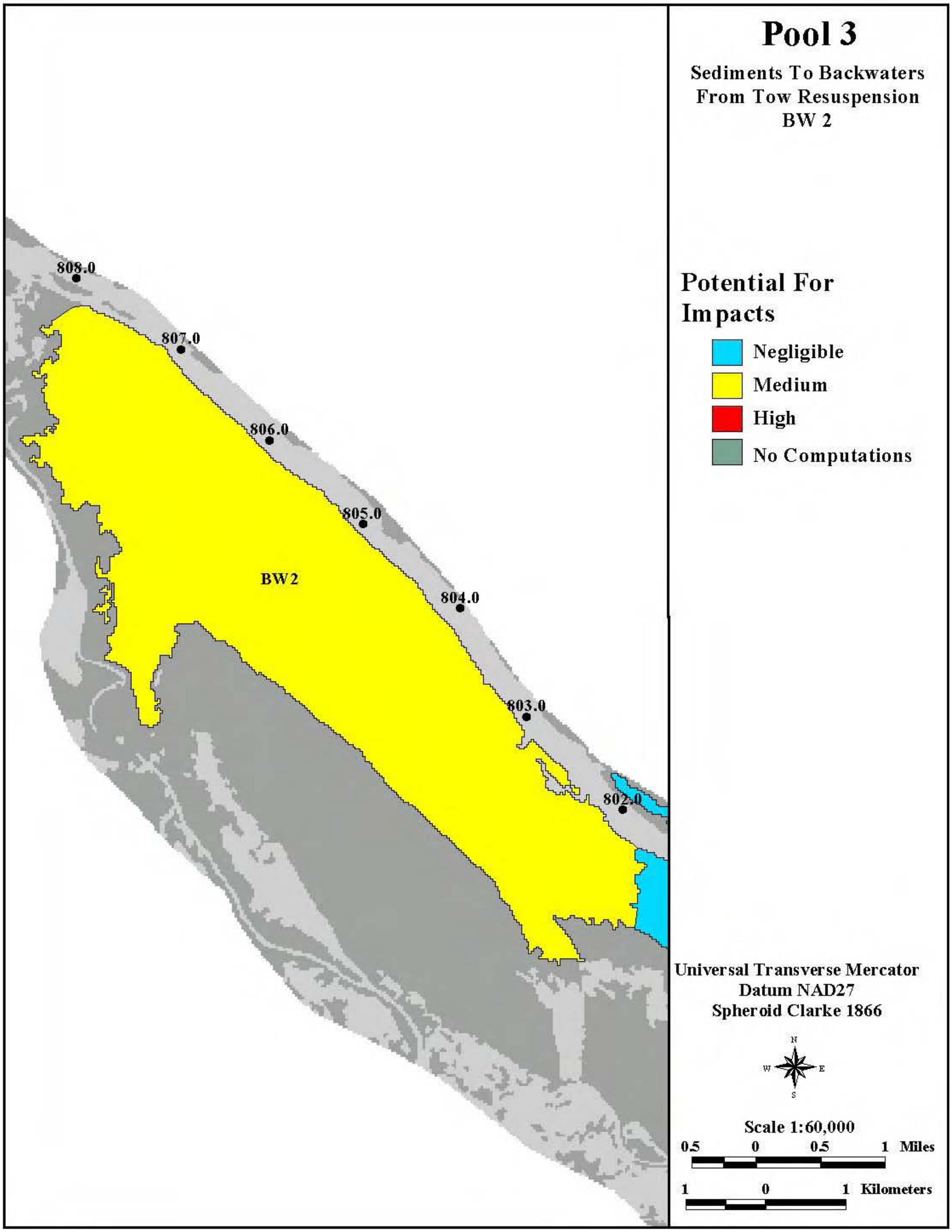
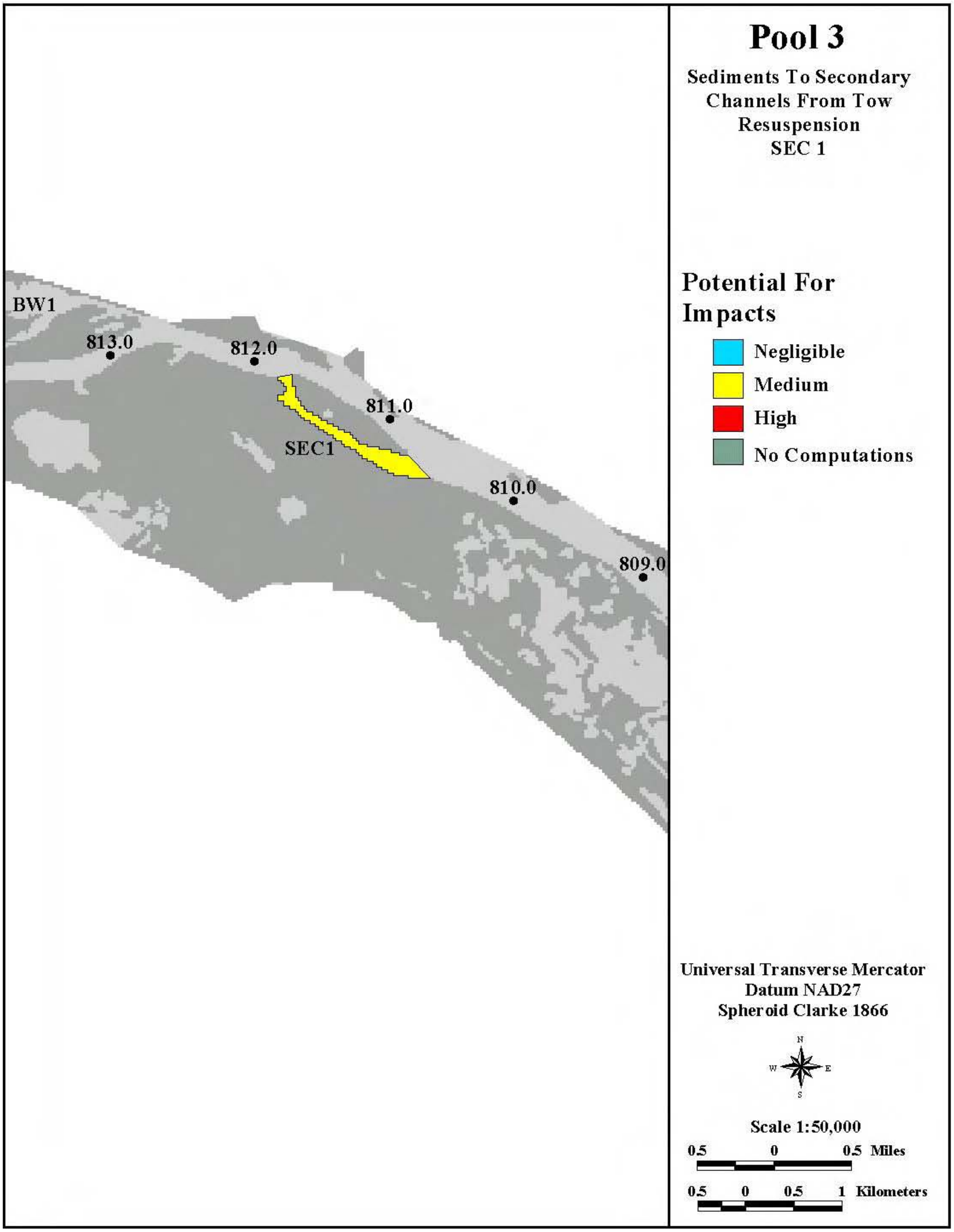

Pool 2
Sediments To Backwaters
From Tow Resuspension
BW 8, BW 10
Potential For Impacts
Negligible
Medium
High
No Computations
830.0
829.0
828.0
827.0
826.0
825.0
824.0
823.0
822.0
821.0
BW6
BW7
BW8
BW9
BW10
BW11
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 14



Pool 3
Sediments To Backwaters
From Tow Resuspension
BW 2
Potential For Impacts
Negligible
Medium
High
No Computations
808.0
807.0
806.0
805.0
804.0
803.0
802.0
BW2
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:60,000
0.5
0
0.5
1
Miles
1
0
1
Kilometers



Pool 3
Sediments To Secondary Channels From Tow Resuspension
SEC 1
Potential For Impacts
Negligible
Medium
High
No Computations
BW1
813.0
812.0
811.0
SEC1
810.0
809.0
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 16

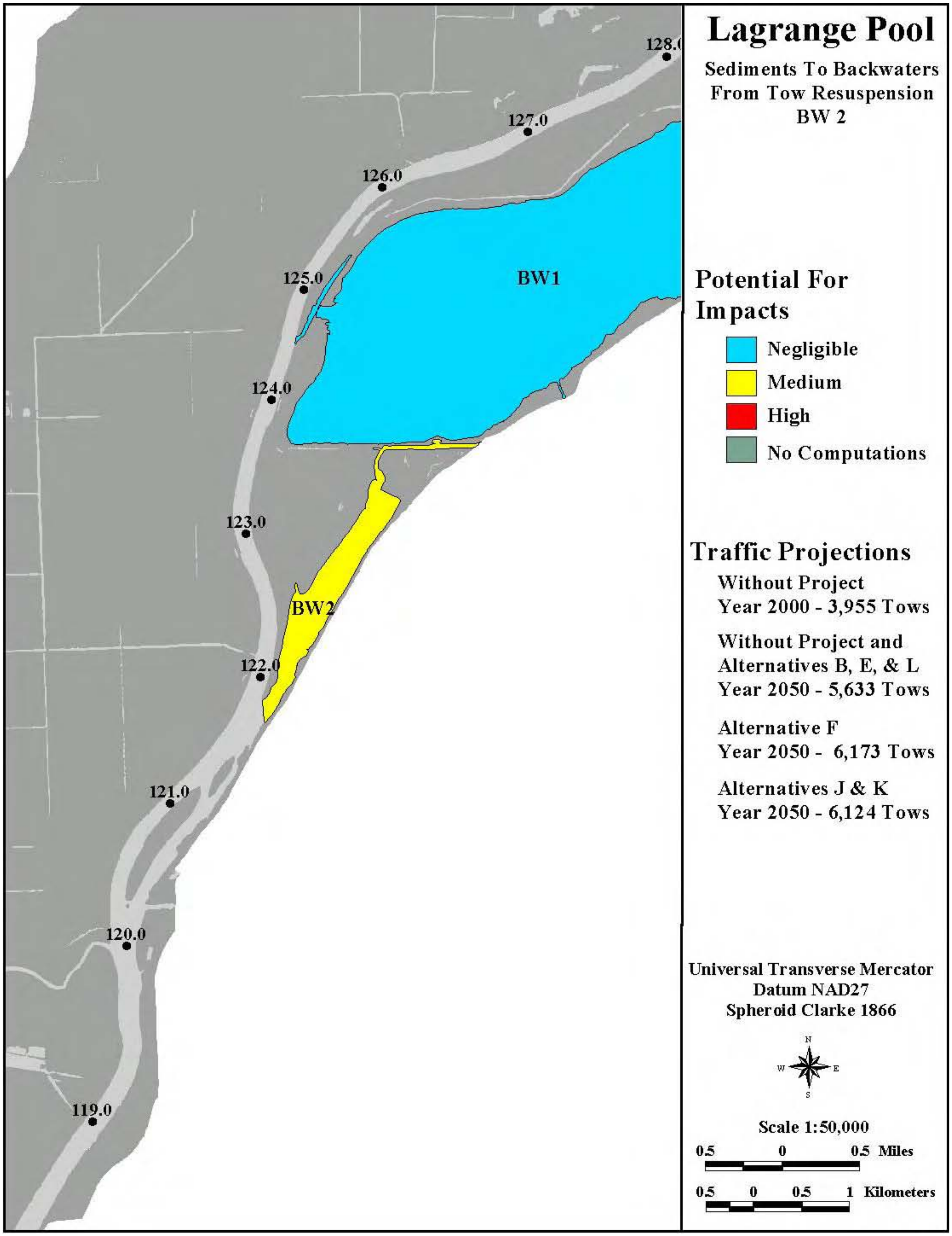
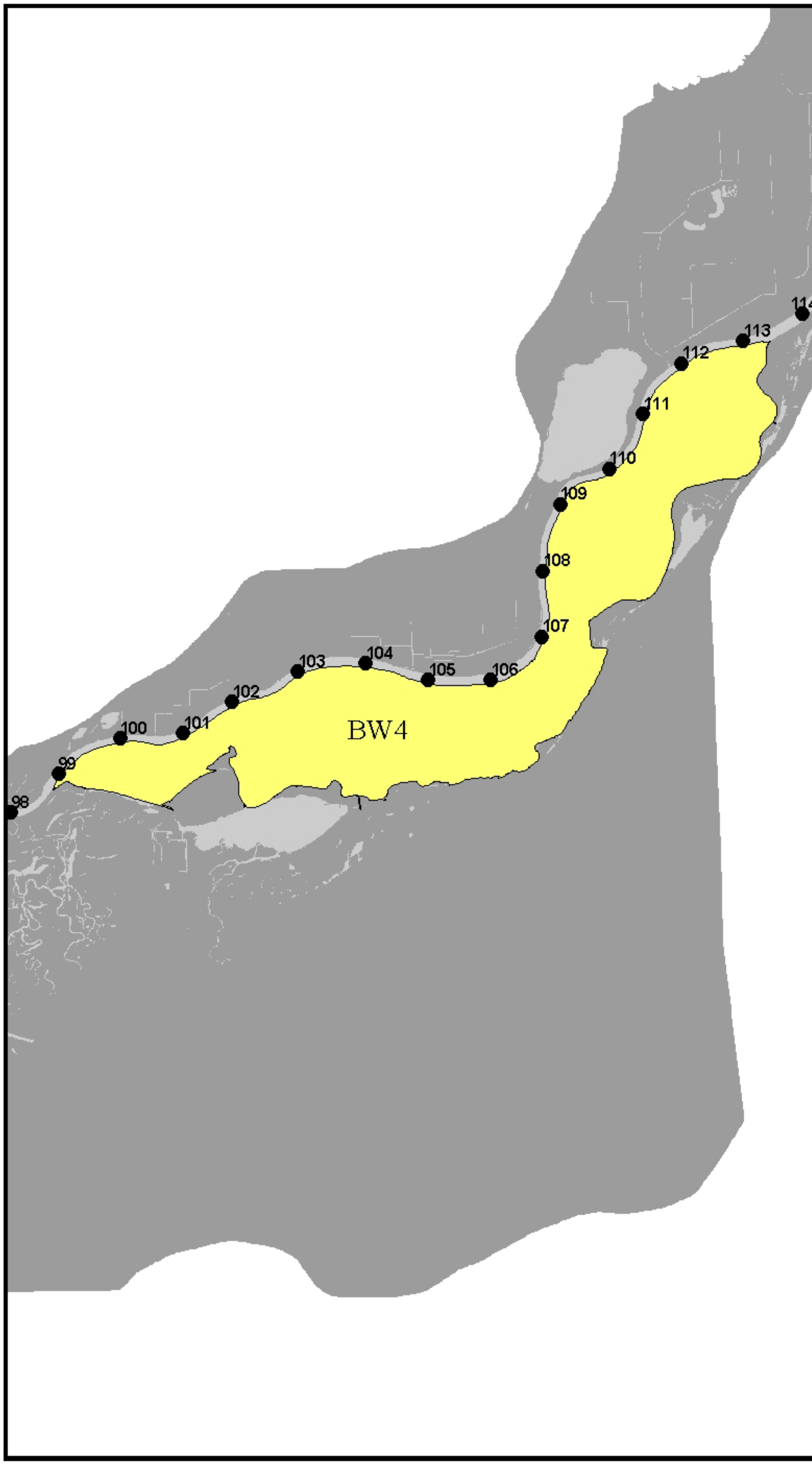

Lagrange Pool
Sediments To Backwaters
From Tow Resuspension
BW 2
Potential For Impacts
Negligible
Medium
High
No Computations
Traffic Projections
Without Project
Year 2000 - 3,955 Tows
Without Project and
Alternatives B, E, & L
Year 2050 - 5,633 Tows
Alternative F
Year 2050 - 6,173 Tows
Alternatives J & K
Year 2050 - 6,124 Tows
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
BW1
BW2
127.0
126.0
125.0
124.0
123.0
122.0
121.0
120.0
119.0

Plate 17



Lagrange Pool

Sediments To Backwater From Tow Resuspension

BW4

Potential For Impacts

- Negligible
- Medium
- High
- No Computations

Traffic Projections

Without Project
Year 2000 - 3,955 Tows

Without Project and Alternatives B, E, & L
Year 2050 - 5,633 Tows

Alternative F
Year 2050 - 6,173 Tows

Alternatives J & K
Year 2050 - 6,124 Tows

"Note: Negligible Impact Potential for Without Project - Year 2000 and Medium Impact Potential for remainder of traffic projections and alternatives."

Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866

Scale: 1:140,000

1 0.5 0 1 2 Miles

1 0.5 0 1 2 Kilometers

Plate 18

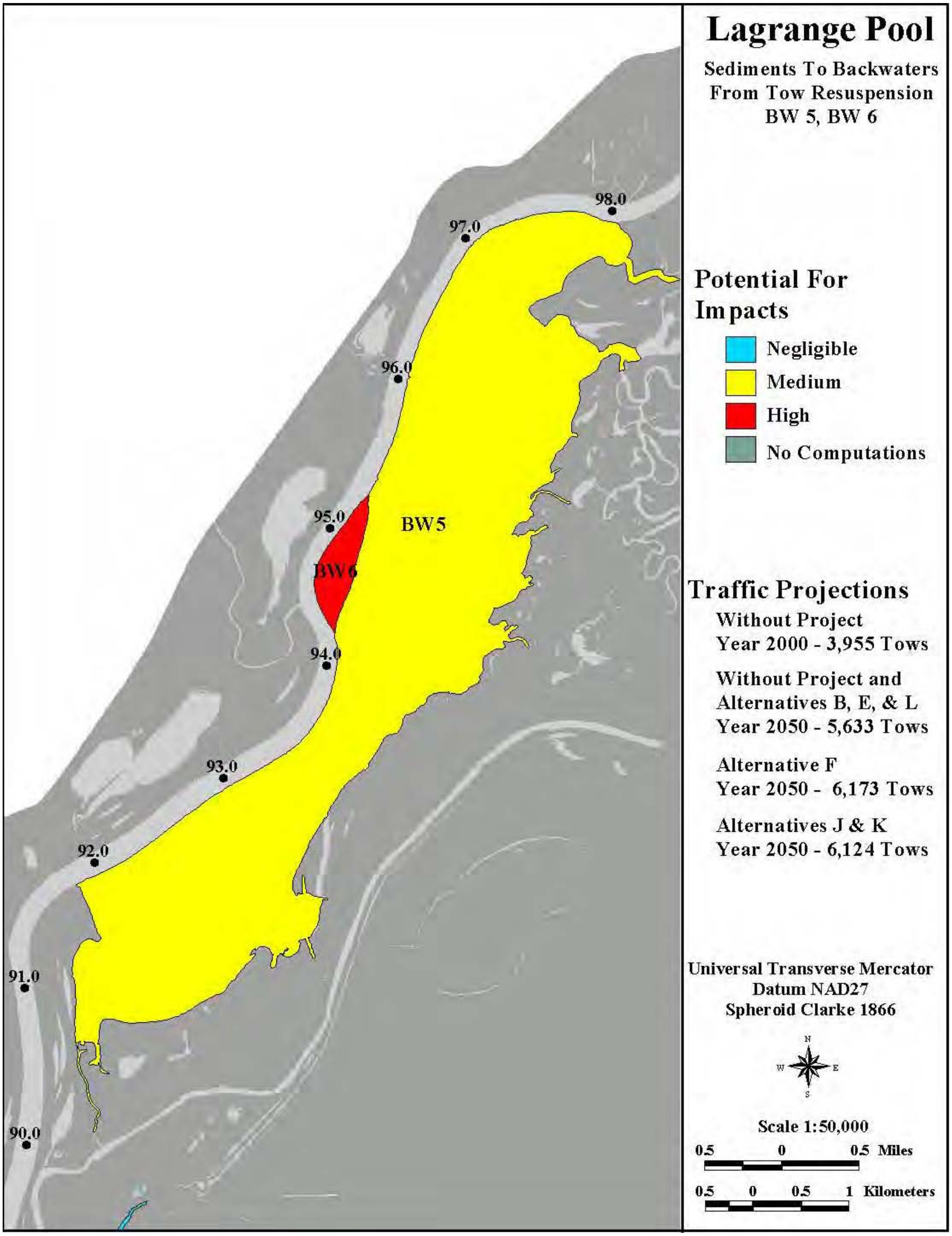

Lagrange Pool
Sediments To Backwaters From Tow Resuspension
BW 5, BW 6
98.0
97.0
96.0
95.0
94.0
93.0
92.0
91.0
90.0
BW5
BW6
Potential For Impacts
Negligible
Medium
High
No Computations
Traffic Projections
Without Project
Year 2000 - 3,955 Tows
Without Project and
Alternatives B, E, & L
Year 2050 - 5,633 Tows
Alternative F
Year 2050 - 6,173 Tows
Alternatives J & K
Year 2050 - 6,124 Tows
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 19

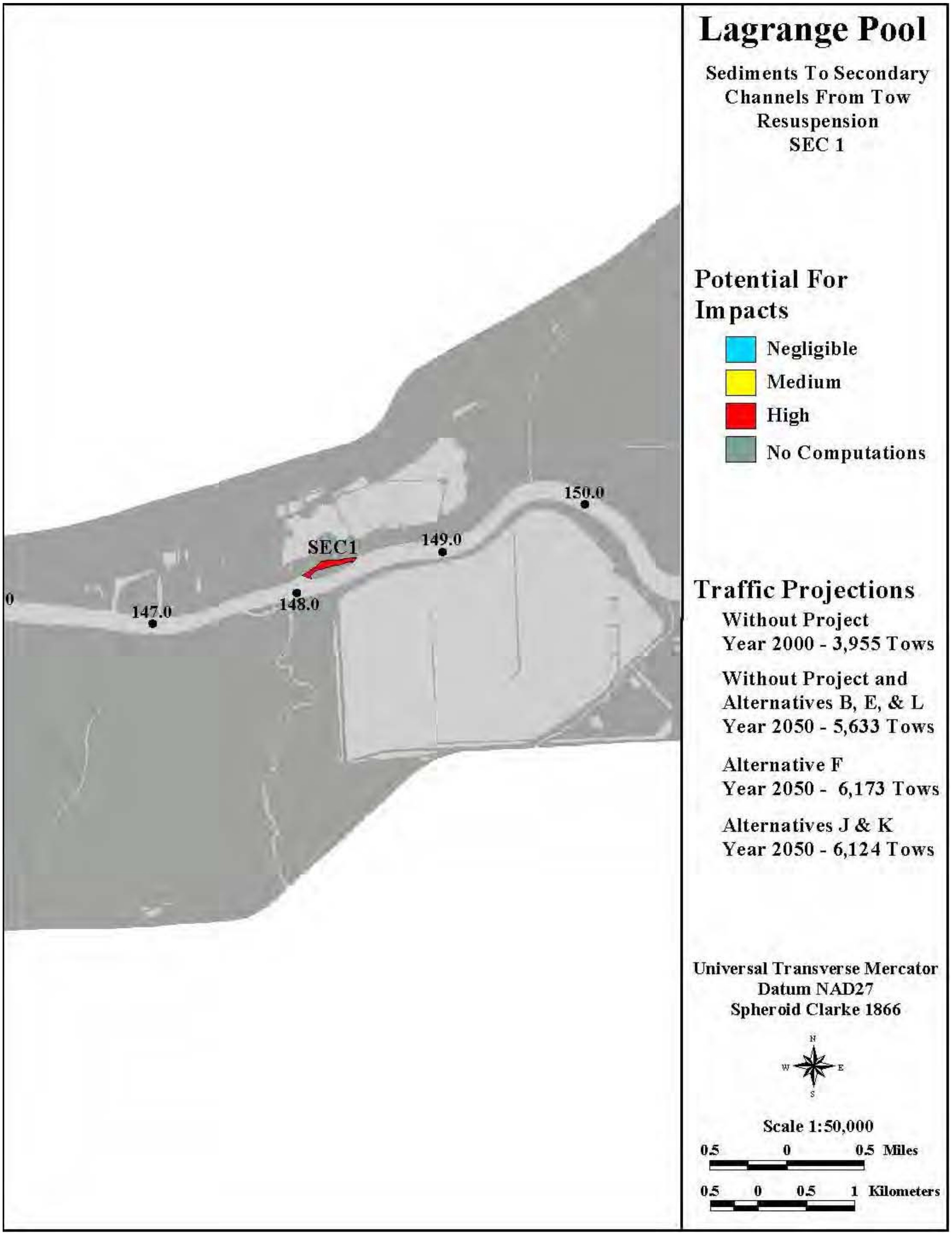
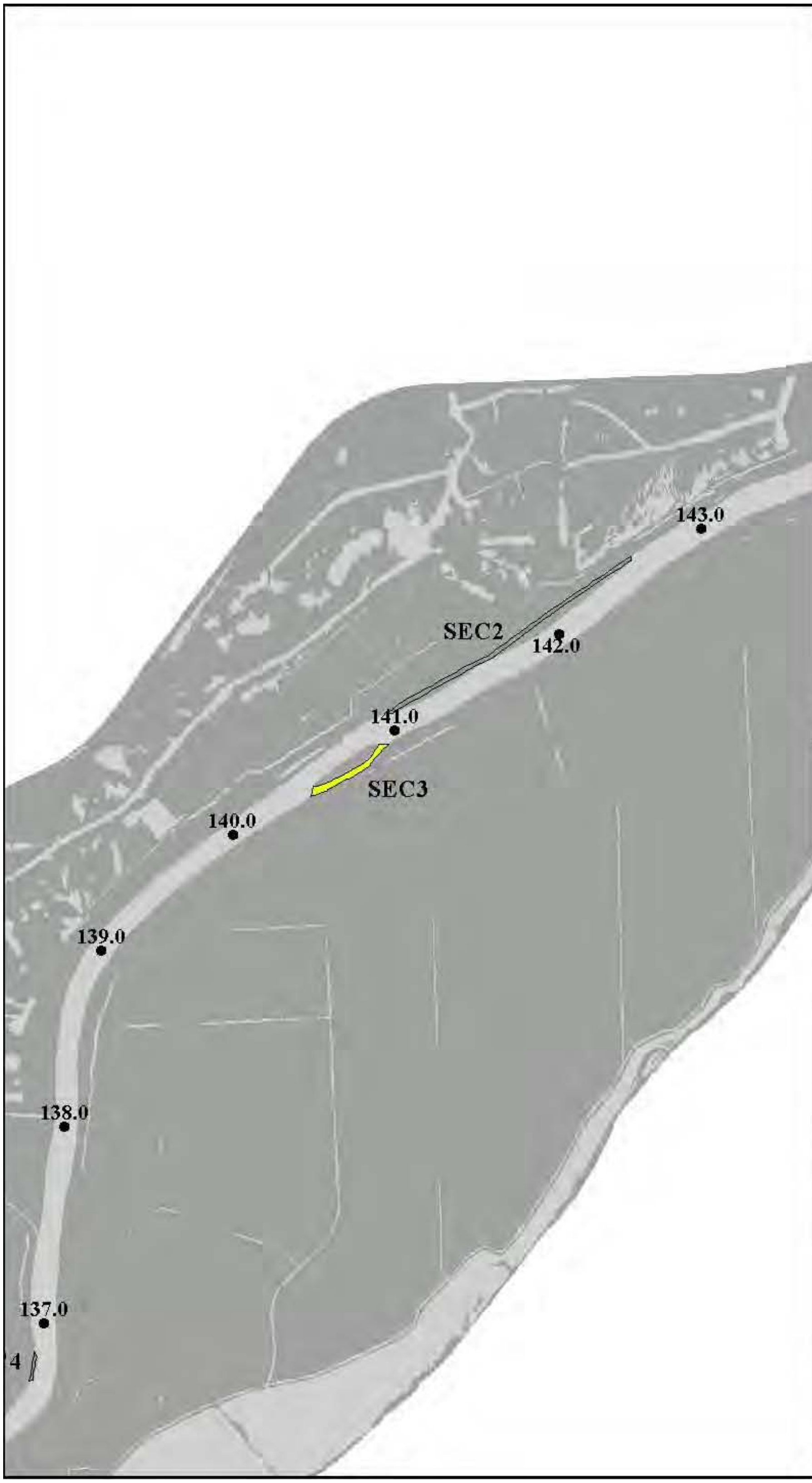

Lagrange Pool
Sediments To Secondary Channels From Tow Resuspension
SEC 1
Potential For Impacts
Negligible
Medium
High
No Computations
Traffic Projections
Without Project
Year 2000 - 3,955 Tows
Without Project and Alternatives B, E, & L
Year 2050 - 5,633 Tows
Alternative F
Year 2050 - 6,173 Tows
Alternatives J & K
Year 2050 - 6,124 Tows
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
SEC1
147.0
148.0
149.0
150.0

Plate 20



Lagrange Pool

Sediments To Secondary Channels From Tow Resuspension
SEC 3

Potential For Impacts

- Negligible
- Medium
- High
- No Computations

Traffic Projections

Without Project
Year 2000 - 3,955 Tows

Without Project and
Alternatives B, E, & L
Year 2050 - 5,633 Tows

Alternative F
Year 2050 - 6,173 Tows

Alternatives J & K
Year 2050 - 6,124 Tows

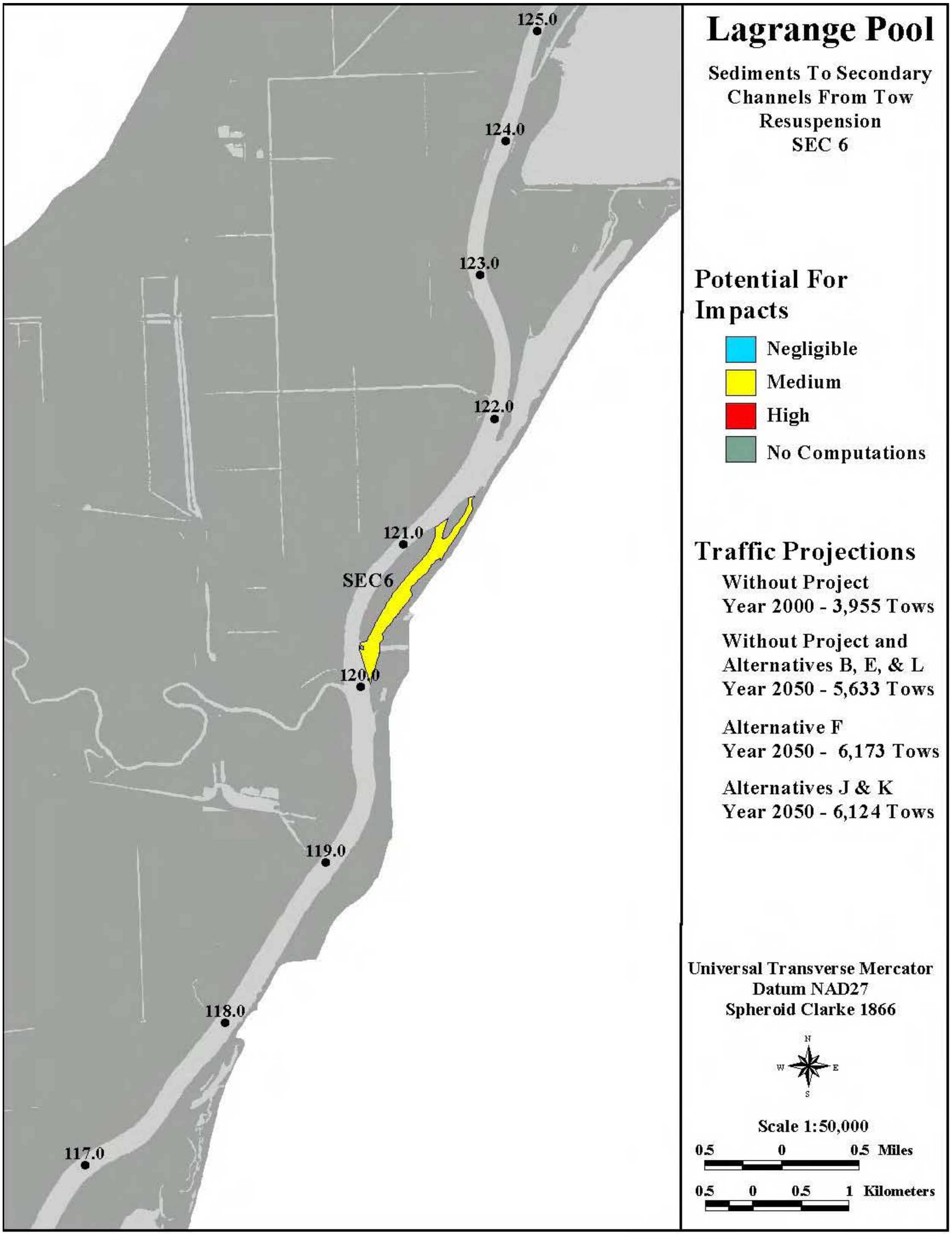
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866

N W E S

Scale 1:50,000

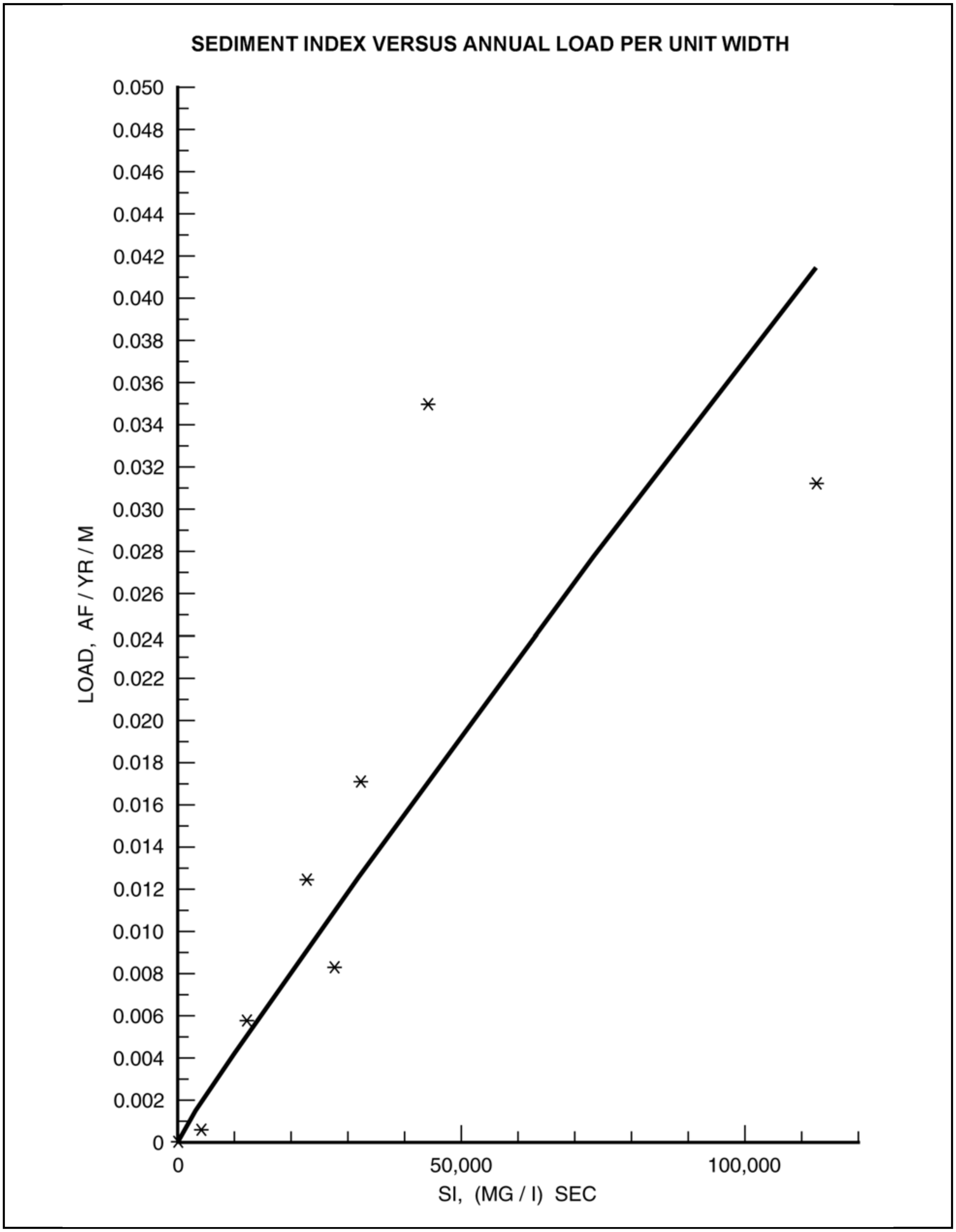
0.5 0 0.5 Miles

0.5 0 0.5 1 Kilometers



125.0
124.0
123.0
122.0
121.0
SEC6
120.0
119.0
118.0
117.0
Lagrange Pool
Sediments To Secondary Channels From Tow Resuspension
SEC 6
Potential For Impacts
Negligible
Medium
High
No Computations
Traffic Projections
Without Project
Year 2000 - 3,955 Tows
Without Project and Alternatives B, E, & L
Year 2050 - 5,633 Tows
Alternative F
Year 2050 - 6,173 Tows
Alternatives J & K
Year 2050 - 6,124 Tows
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 22


SEDIMENT INDEX VERSUS ANNUAL LOAD PER UNIT WIDTH
LOAD, AF / YR / M
0.050
0.048
0.046
0.044
0.042
0.040
0.038
0.036
0.034
0.032
0.030
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0
0
50,000
100,000
SI, (MG / l) SEC

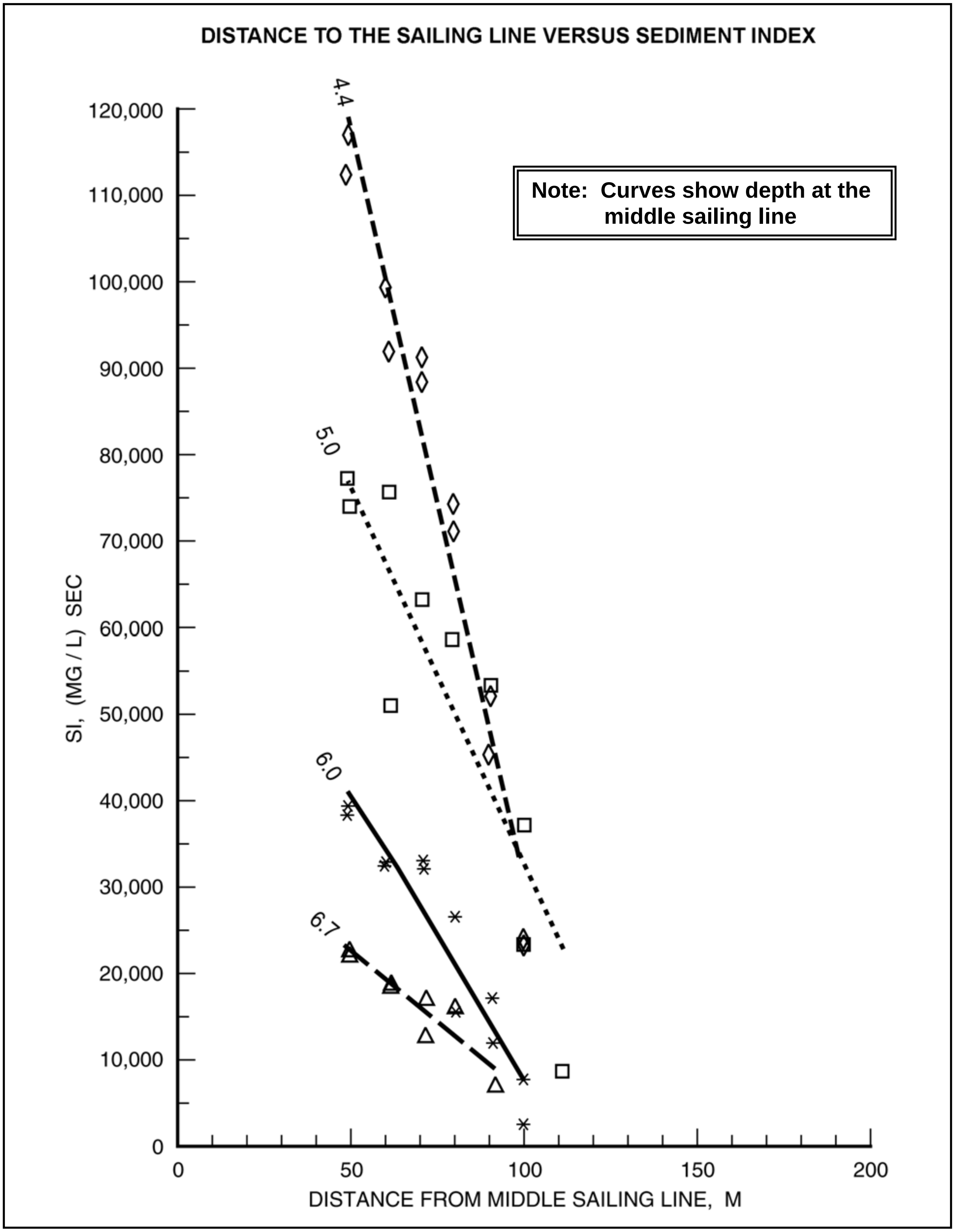
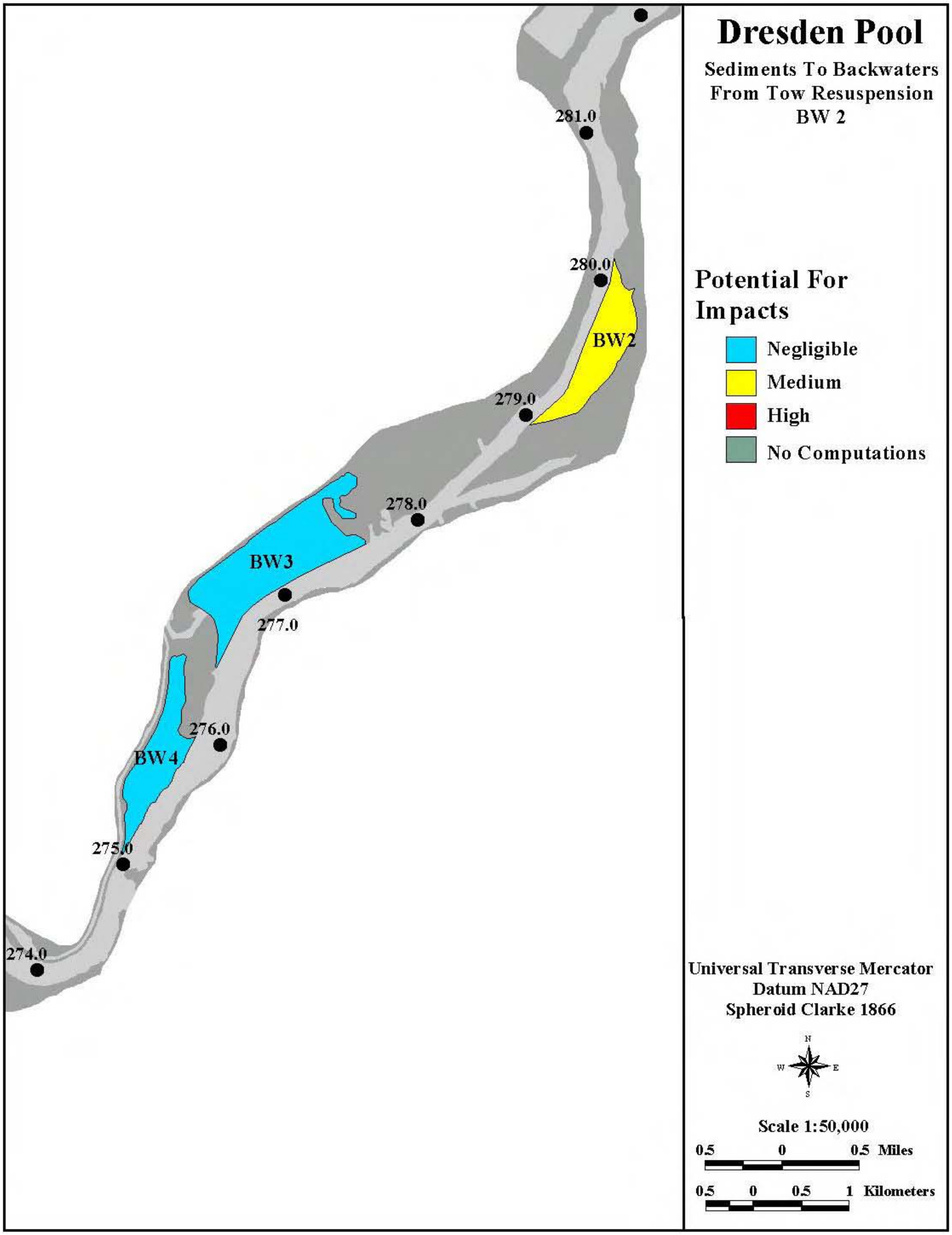

DISTANCE TO THE SAILING LINE VERSUS SEDIMENT INDEX
Note: Curves show depth at the middle sailing line
SI, (MG / L) SEC
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
0
50
100
150
200
DISTANCE FROM MIDDLE SAILING LINE, M
4.4
5.0
6.0
6.7

Plate 24



Dresden Pool
Sediments To Backwaters
From Tow Resuspension
BW 2
281.0
280.0
BW2
279.0
278.0
BW3
277.0
276.0
BW4
275.0
274.0
Potential For Impacts
Negligible
Medium
High
No Computations
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 25

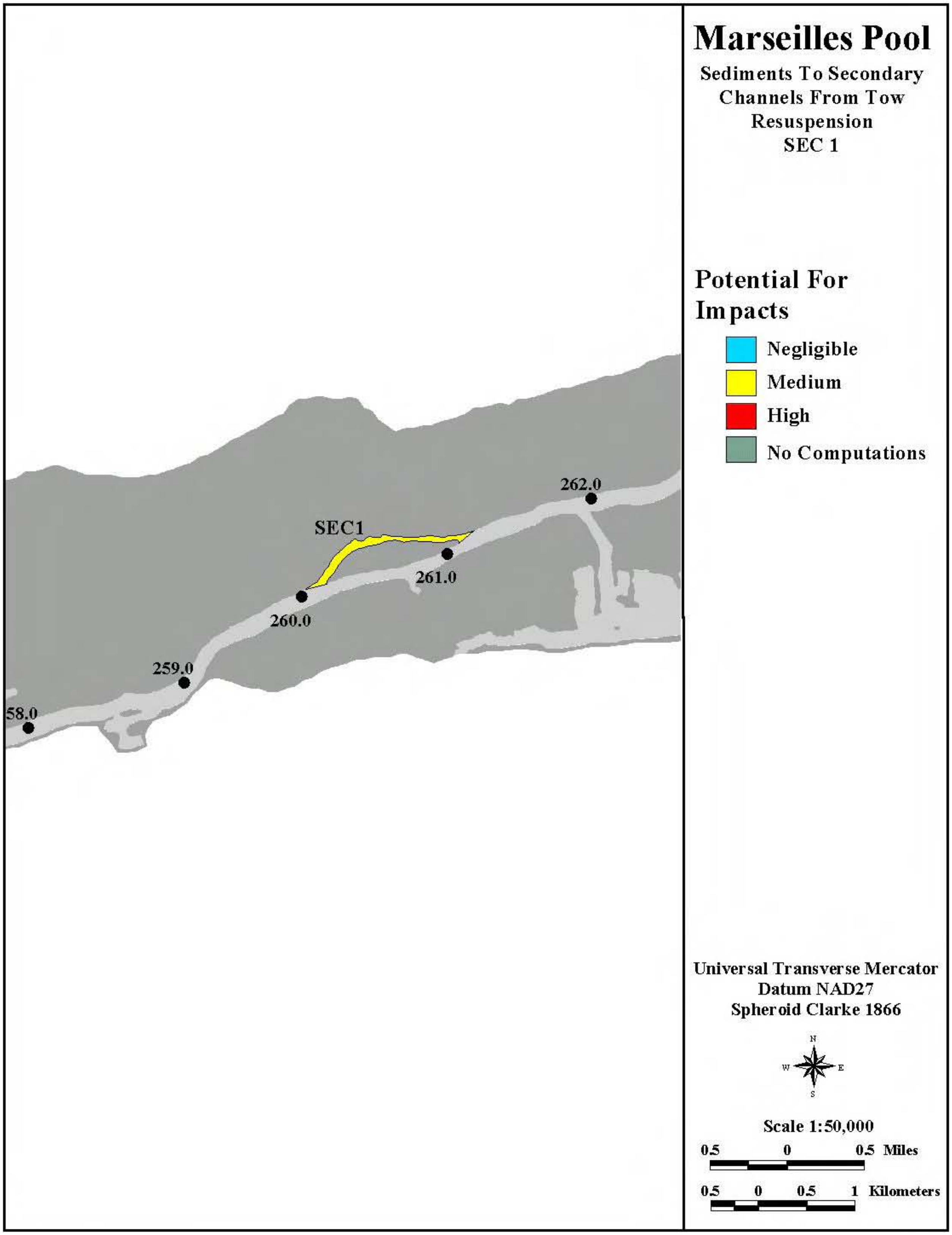
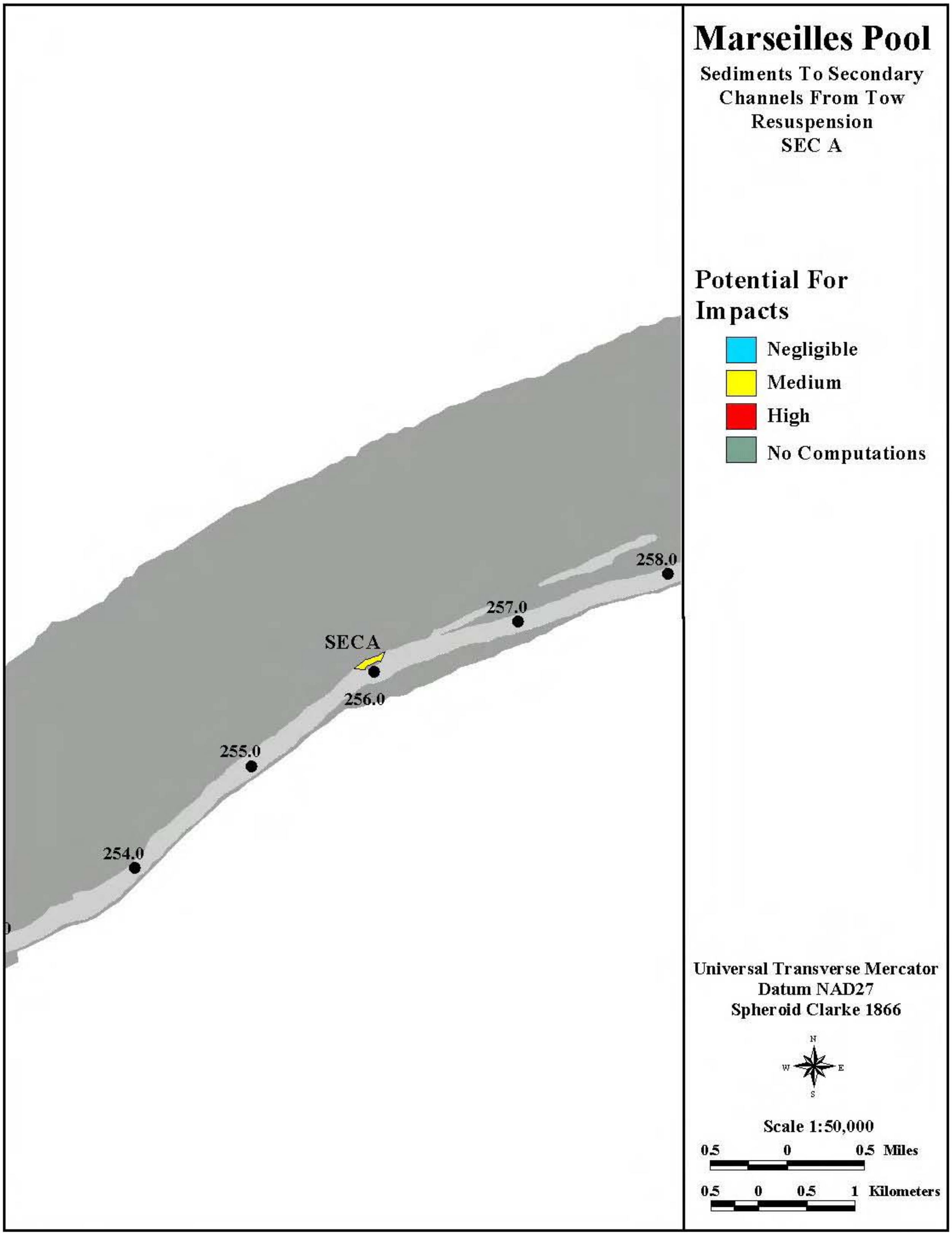

Marseilles Pool
Sediments To Secondary Channels From Tow Resuspension
SEC 1
Potential For Impacts
Negligible
Medium
High
No Computations
SEC1
262.0
261.0
260.0
259.0
58.0
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 26


Marseilles Pool
Sediments To Secondary Channels From Tow Resuspension
SEC A
Potential For Impacts
Negligible
Medium
High
No Computations
SECA
258.0
257.0
256.0
255.0
254.0
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5
0
0.5
Miles
0.5
0
0.5
1
Kilometers

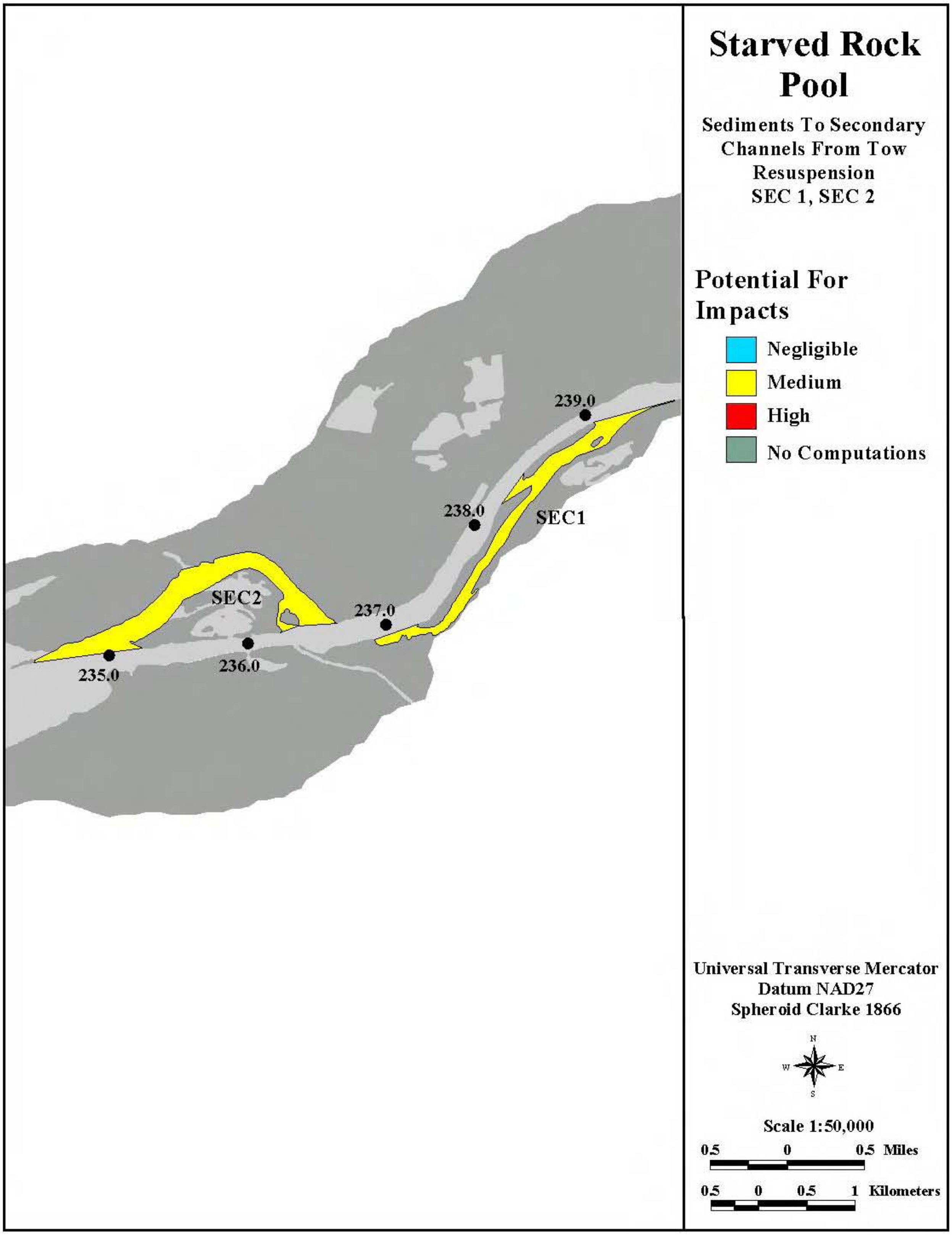
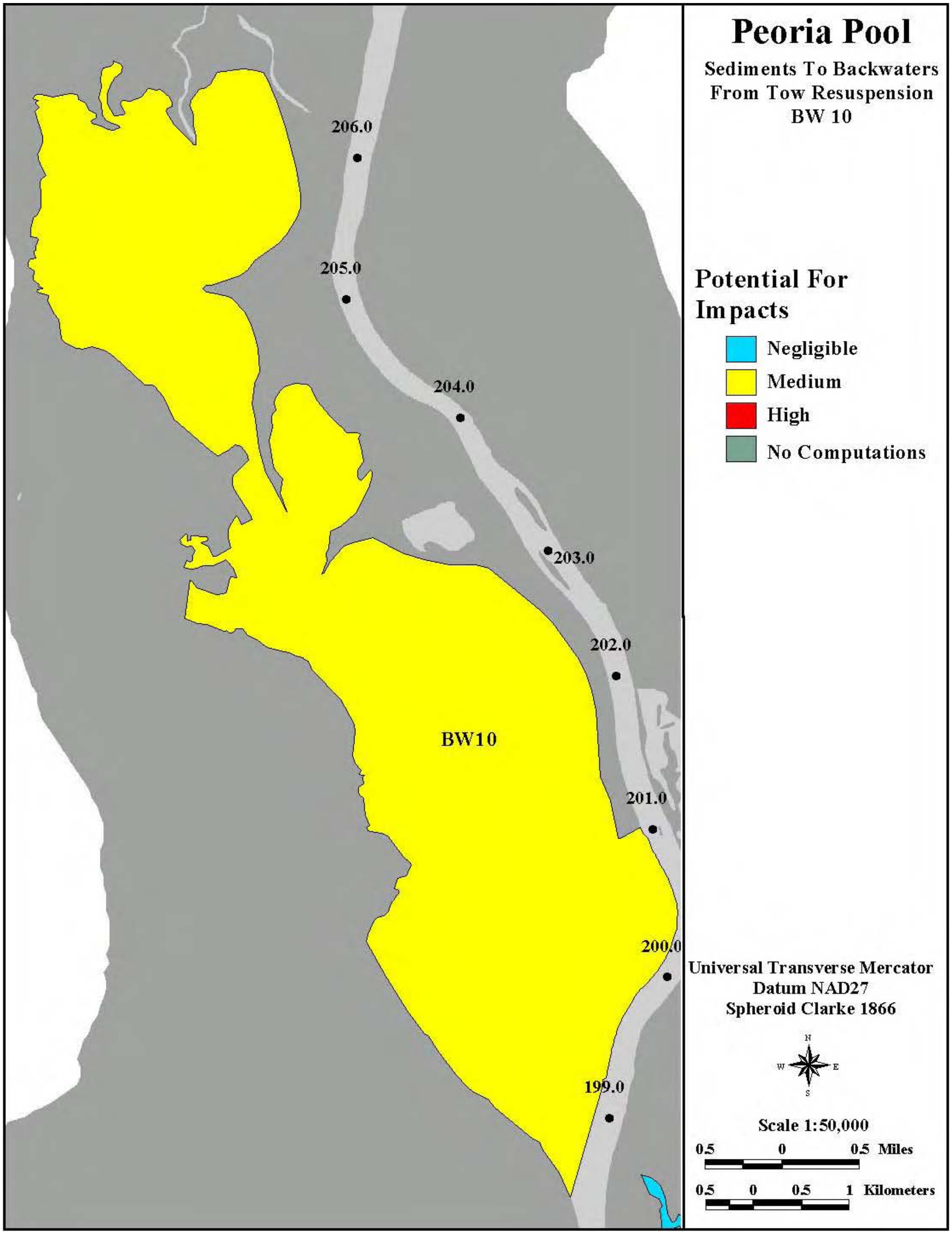
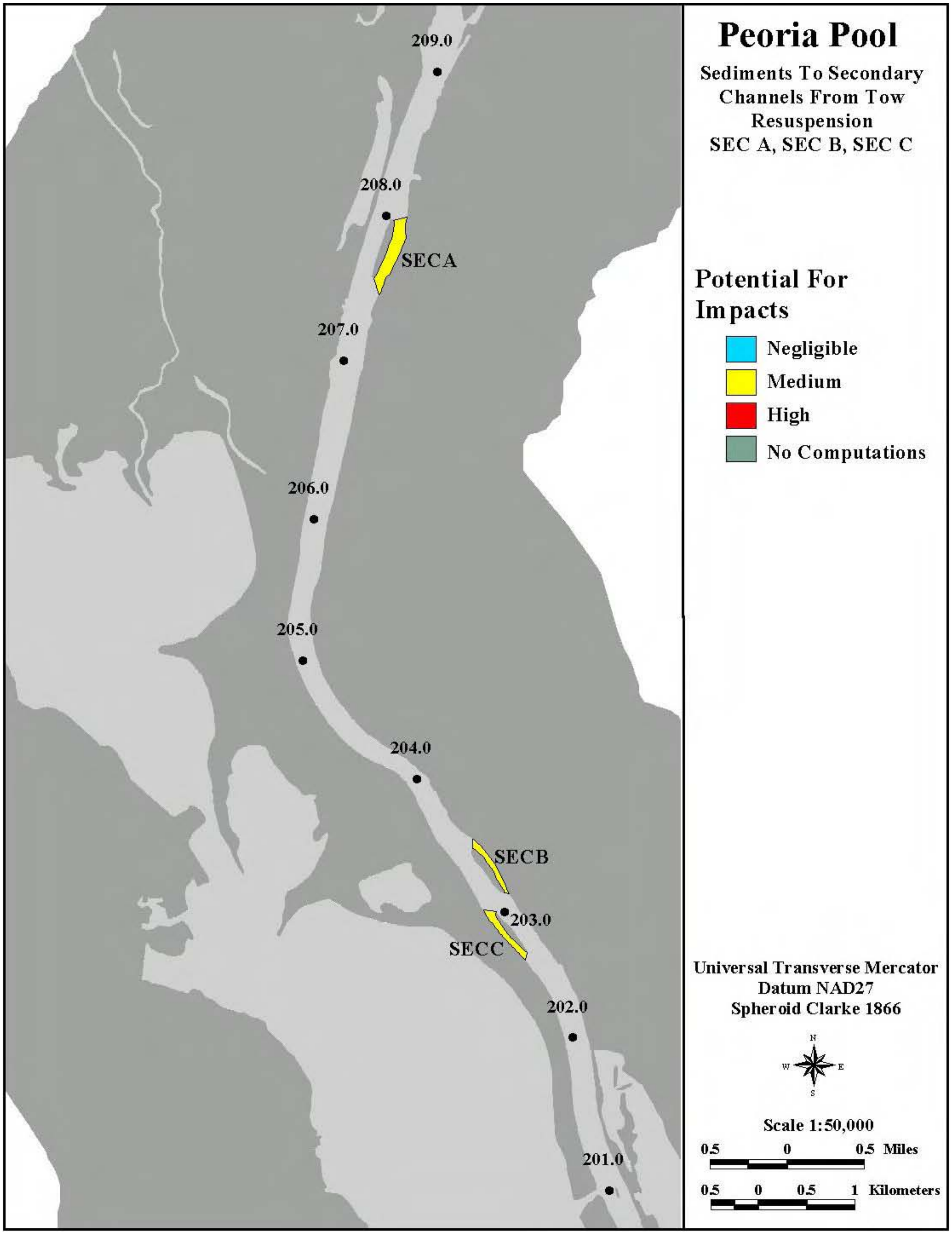

Starved Rock Pool
Sediments To Secondary Channels From Tow Resuspension
SEC 1, SEC 2
Potential For Impacts
Negligible
Medium
High
No Computations
239.0
238.0
237.0
236.0
235.0
SEC1
SEC2
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 28



Peoria Pool
Sediments To Backwaters
From Tow Resuspension
BW 10
Potential For Impacts
Negligible
Medium
High
No Computations
206.0
205.0
204.0
203.0
202.0
201.0
200.0
199.0
BW10
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers



Peoria Pool
Sediments To Secondary Channels From Tow Resuspension
SEC A, SEC B, SEC C
Potential For Impacts
Negligible
Medium
High
No Computations
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
209.0
208.0
SECA
207.0
206.0
205.0
204.0
SECB
203.0
SECC
202.0
201.0

Plate 30

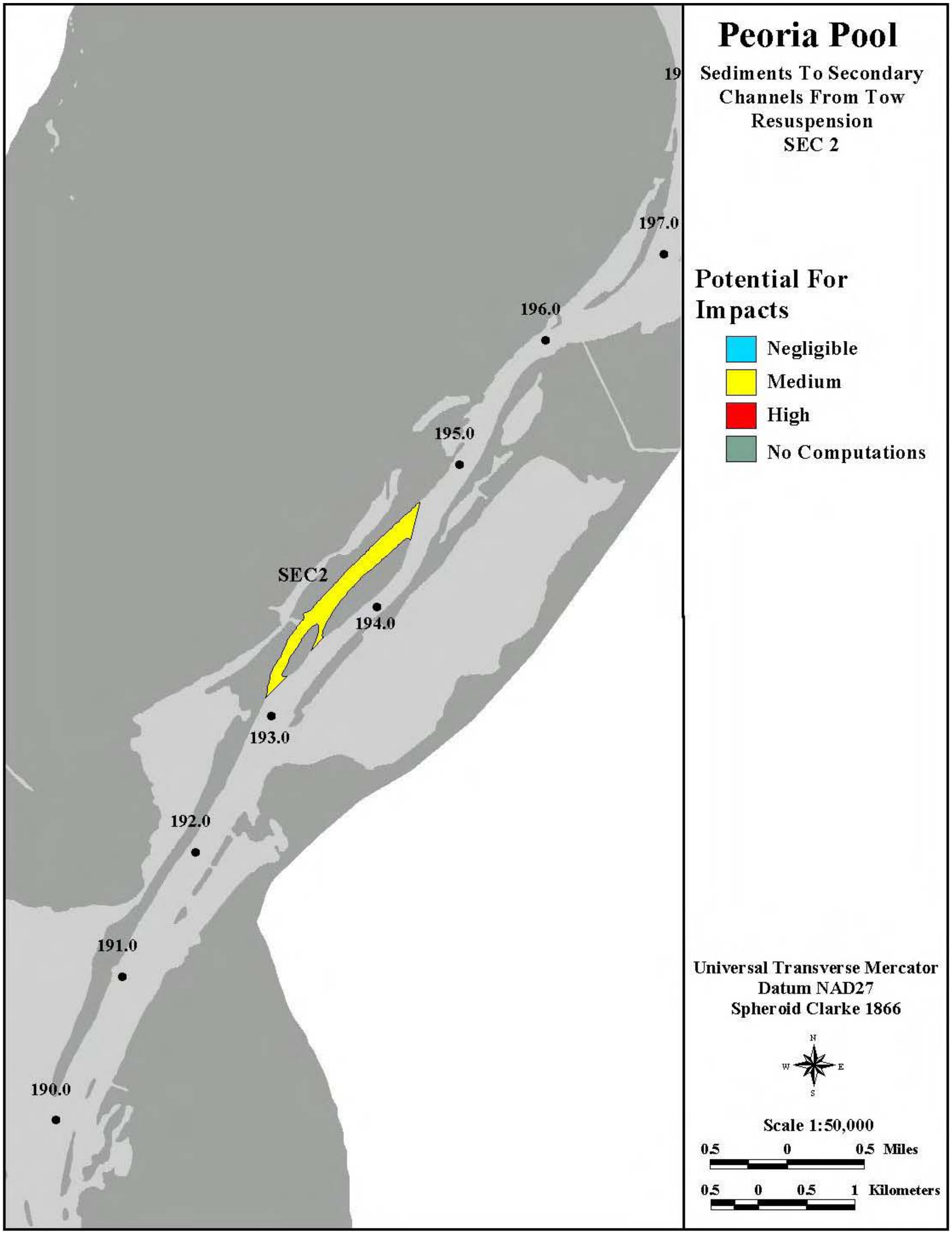

Peoria Pool
Sediments To Secondary Channels From Tow Resuspension
SEC 2
Potential For Impacts
Negligible
Medium
High
No Computations
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
SEC2
197.0
196.0
195.0
194.0
193.0
192.0
191.0
190.0
19

Plate 31

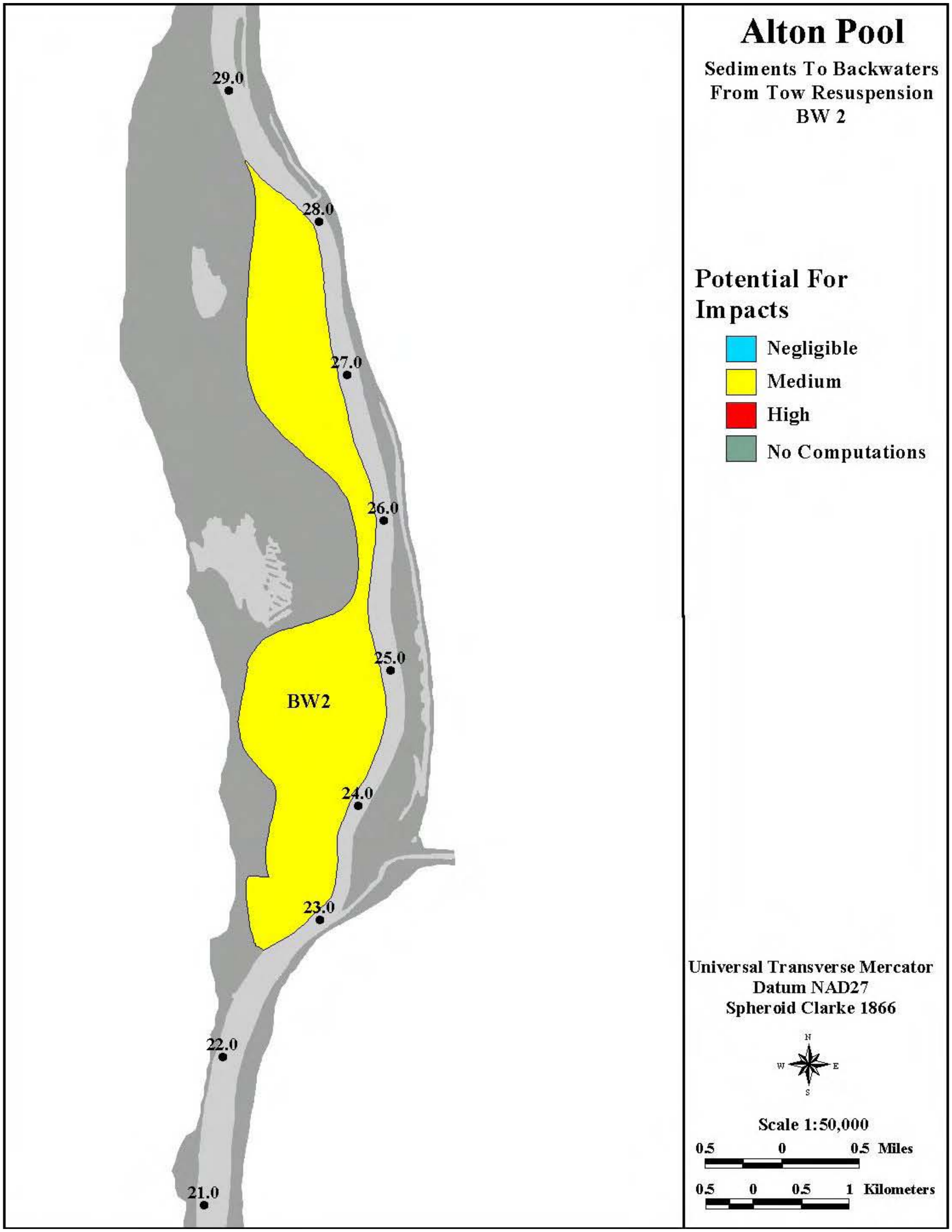
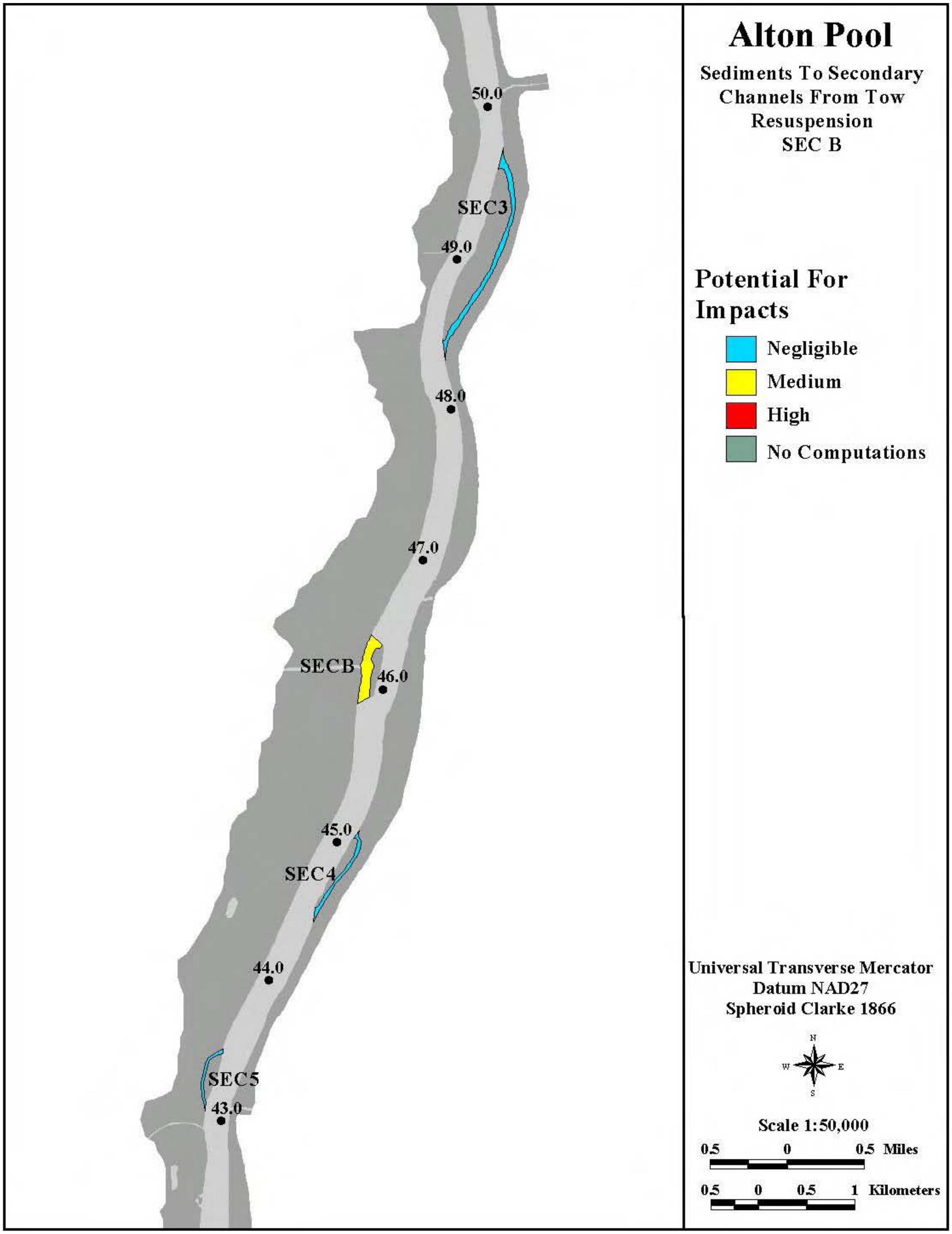
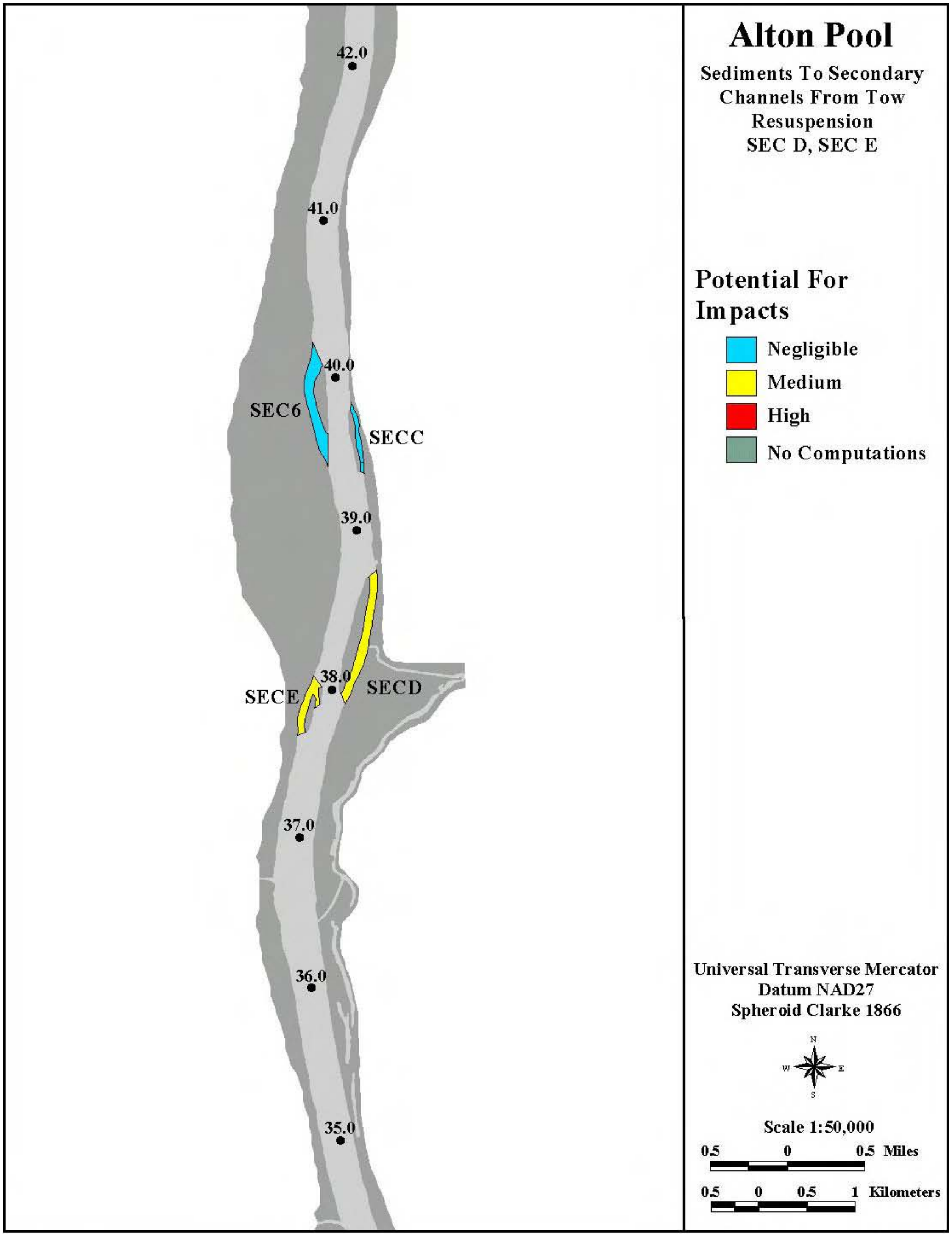
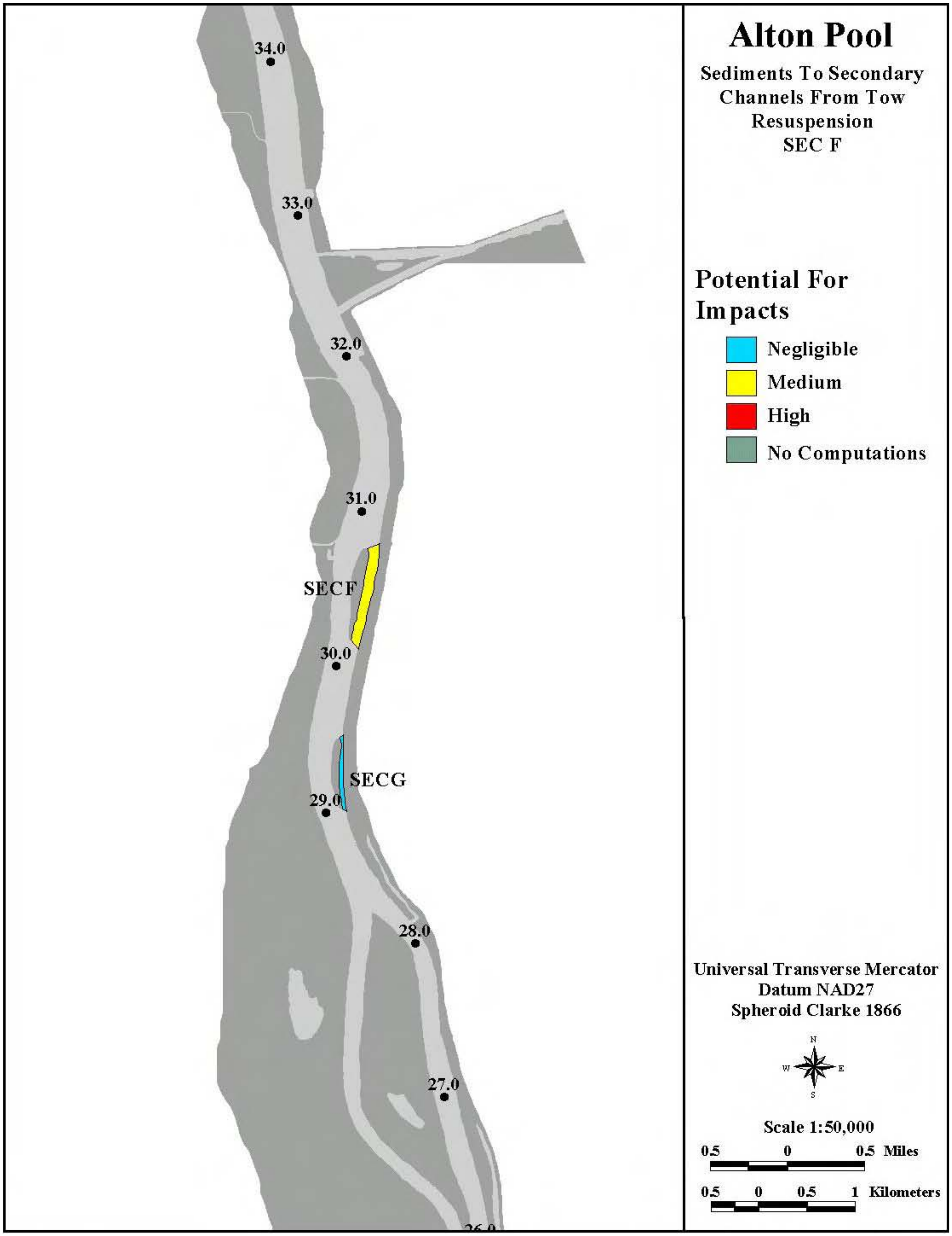

Alton Pool
Sediments To Backwaters
From Tow Resuspension
BW 2
Potential For Impacts
Negligible
Medium
High
No Computations
29.0
28.0
27.0
26.0
25.0
BW2
24.0
23.0
22.0
21.0
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers

Plate 32



Alton Pool
Sediments To Secondary Channels From Tow Resuspension
SEC B
Potential For Impacts
Negligible
Medium
High
No Computations
50.0
SEC3
49.0
48.0
47.0
SECB
46.0
45.0
SEC4
44.0
SEC5
43.0
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers


Alton Pool
Sediments To Secondary Channels From Tow Resuspension
SEC D, SEC E
Potential For Impacts
Negligible
Medium
High
No Computations
42.0
41.0
40.0
SEC6
SECC
39.0
38.0
SECE
SECD
37.0
36.0
35.0
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers


Alton Pool
Sediments To Secondary Channels From Tow Resuspension
SEC F
Potential For Impacts
Negligible
Medium
High
No Computations
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
S
E
W
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 Kilometers
34.0
33.0
32.0
31.0
SECF
30.0
SECG
29.0
28.0
27.0

Appendix A
Estimation of Vessel-Induced Exchange for the Upper Mississippi River Study

As a vessel moves along a waterway, it produces a drawdown around the vessel. Areas surrounding the channel tend to empty as the vessel passes, and then refill. In fact, this can cause a resonant oscillation in the backwater or secondary channels that can produce a diminishing empty/fill cycle. Often this vessel-induced exchange is small compared to typical flow exchange at the entrance of a backwater or the net flushing in a secondary channel. However, this may not always be the case.

As part of the Upper Mississippi River and Illinois Waterway Navigation Study an extensive portion of Pools 8 and 26 on the Upper Mississippi River and the LaGrange Pool on the Illinois Waterway were hydrodynamically modeled. This included the river flow, as well as representation of the passage of a tow/barge vessel. However, estimates of sedimentation over the entire waterway were required. It is not practical to model the entire waterway numerically using two-dimensional models for all of the possible vessel speeds and configurations. Therefore, a method of estimating the vessel-induced exchange was needed. In reality, since the bathymetry of the backwaters and secondary channels profoundly influences the amount of exchange, the best that can be expected, short of modeling, is to produce a conservative estimate. In this case, conservative means overestimating the impact of the vessel.

The procedure adopted involved a linearization of the shallow-water equations, energy losses for entrance/exits and bed friction based upon the cycle average, and very simplified assumptions about geometry of the backwater or secondary channel. The drawdown due to the vessel will be input data along with the vessel speed and length.

Considering a single-opening inlet backwater, the solutions of the linearized one-dimensional shallow-water equations can be found as (Currie 1974)[1]

[1] References cited in this appendix are listed in the References at the end of the main text.

$$\eta(x, t) = l(x + ct) + r(x - ct) \quad \text{(A1)}$$

$$\hat{u}(x, t) = \frac{c}{H}[-l(x + ct) + r(x - ct)] \quad \text{(A2)}$$

where

η = the deflection in water surface from H

x = a spatial coordinate which falls along the channel axis

t = time

l, r = functions associated with left and right propagating waves

c = $(gH)^{1/2}$

g = gravity-induced acceleration

$\hat{u}$ = the channel velocity

H = the nominal channel depth

Here the average channel velocity was assumed to be zero and $\hat{u}$ and η are small.

Given the maximum drawdown in the channel near the backwater inlet for two nearby points (designated as either 0 or 1), the approximate waveform at Point 0 can be determined as

$$\eta_o(t) = A_o \sin\left(-\frac{2\Pi}{T}t\right), \text{ for } -\frac{T}{2} \le t \le 0 \quad \text{(A3)}$$

where T is the total vessel-generated wave length, computed by taking twice the vessel length and dividing by the vessel speed.

The total energy on the interior is known and going to be less than outside the opening by the energy head or

$$\eta_o(t) = \eta_1(t) + \frac{\hat{u}_1^2}{2g} + K\frac{\hat{u}_1^2}{2g} \quad \text{(A4)}$$

where K is an entrance energy loss coefficient = 1.

Choose

$$\eta_1(t) = A_1 \sin\left(-\frac{2\Pi}{T}t\right) \quad \text{(A5)}$$

then

$$\hat{u}_1(t) = \left(\frac{g}{H}\right)^{1/2} A_1 \sin\left(-\frac{2\Pi}{T}t\right) \tag{A6}$$

With this simple approximation, one cannot make this equality true at all times from $-\frac{T}{2} \leq t \leq 0$; therefore, it was decided to make it true on average. The estimate for the amplitude just inside the channel A_1 is

$$A_1 = \frac{2H}{\Pi}\left[-1 + \left(1 + \frac{\Pi}{H}A_o\right)^{1/2}\right] \tag{A7}$$

So a wave amplitude near the entrance of the channel yields a value for the amplitude just inside the channel. The form is the same for exits and entrances; therefore, this equation was used repeatedly for both conditions.

While the actual shape of the channel and slopes of the shore can produce significant losses of the waveform, only a gross approximation using surface friction formulation was used here. The Manning's equation for energy losses was used to get the average energy loss per unit length. This was accomplished in much the same manner as with entrance/exit losses where an effective amplitude was calculated by integration over the period of water-surface deflection.

Considering two nearby points (points 0 and 1) along a prismatic channel separated by a distance of Δx, the energy equation from one point to the other can be written

$$\eta_o(t) + \frac{\hat{u}_o^2(t)}{2g} = \eta_1(t) + \frac{\hat{u}_1^2(t)}{2g} + \left(\frac{n}{C_o R^{2/3}}\right)^2 \hat{u}_1^2(t)\Delta x \tag{A8}$$

where

n = Manning's roughness coefficient

C_o = 1.0 in SI and 1.486 in non-SI units

R = hydraulic radius

Substituting a relationship for amplitude and velocity as

$$\eta_o(t) = A_o \sin\left(-\frac{2\Pi}{T}t\right) \tag{A9}$$

$$\eta_1(t) = A_1 \sin\left(-\frac{2\Pi}{T}t\right) \tag{A10}$$

$$\hat{u}_o\ (t)\ =\ \left(\frac{g}{H}\right)^{1/2} A_o\ \sin\ \left(-\frac{2\Pi\equiv}{T}t\right) \tag{A11}$$

$$\hat{u}_1\ (t)\ =\ \left(\frac{g}{H}\right)^{1/2} A_1\ \sin\ \left(-\frac{2\Pi\equiv}{T}t\right) \tag{A12}$$

Here the phase lag between points was not included, and additional modes were not allowed to develop. Then the relationship in Equation A8 was enforced in an average sense by integrating over the deflection period $-\frac{T}{2} \leq t \leq 0$. The result was:

$$A_o\ +\ \frac{\Pi}{8H}\ A_o^2\ =\ A_1\ +\ \frac{\Pi\equiv}{8H}\ (1\ +\ 2Kg\Delta x)\ A_1^2 \tag{A13}$$

where

$$K\ =\ \left(\frac{n}{C_o R^{2/3}}\right)^2$$

Expanding A_1 in a Taylor Series gives

$$A_1\ =\ A_o\ +\ \frac{\partial A_o}{\partial X}\ \Delta X\ +\ O(\Delta X^2) \tag{A14}$$

The first-order relationship for $\frac{\partial A_o}{\partial X}$ is as follows:

$$\frac{\partial A_o}{\partial X}\ =\equiv -\frac{\gamma K g A_o^2}{1\ +\ \gamma A_o} \tag{A15}$$

or where

$$\gamma\equiv\ \frac{\Pi}{4H}$$

$$A_1\ =\ A_o\ -\ \frac{\gamma K g A_o^2}{1\ +\ \gamma A_o}\ \Delta X$$

This relationship was then used as a low-order approximation for the entire channel length.

This procedure was tested for two cases. The first was termed a backwater and the second a secondary channel. In this case the backwater has a single opening from the main river into a channel that is closed. The secondary channel essentially is the channel produced by a nearshore island. The secondary channel has openings to the main-stem river at each end. Both test examples were from the Pool 8 numerical model simulation.

Backwater

Figure A1 shows the test example backwater. The behavior at the entrance is shown in Figure A2 for water surface, and Figure A3 is the velocity history. The testing procedure was a simplification of this system that accounts only for the drawdown around the vessel. The simulation represents a water surface that is flat except for a depression around the vessel centered at time 48 minutes. The water surface at the inlet, after the vessel passage, would rebound to the same flat elevation as before the vessel. The connection to the mainstream at the inlet then functions as a large reservoir in which the elevation is dictated by the reservoir elevation. A depression that enters the backwater channel will produce a resonance in the channel with period $4L/c$, where L is the channel length. Assuming that the length of the depression wave is less than twice the channel length, then the behavior can be described as a wave moving back and forth in the channel. The first quarter of the cycle is a depression wave producing flow velocity toward the mainstream. At the entrance this results in "emptying" of the backwater. The wave reaches the closed end of the channel and is reflected as a depression wave but with velocity toward the closed end of the channel. The second quarter of the cycle is this depression wave moving toward the inlet with closed-end directed velocity. This results in a "filling" of the backwater. When the depression wave reaches the inlet, the entrance acts as a fixed-elevation reservoir sending a surge (positive wave) up the channel. This surge also has velocities directed toward the closed end. So at the entrance, when the outward-moving depression wave meets the inward-directed surge, the water surface remains at a constant elevation, but the magnitude of the filling velocity doubles. In this manner the channel is overfilled and a positive wave propagates up and back in the channel, completing one cycle. If there is little friction or other losses, this cycle can bounce back and forth in the channel for many cycles. One noticeable result is that the filling velocity, which occurs at $t = 2L/c$ after the peak emptying velocity as the vessel passes, can be as much as twice this initial peak exit velocity.

Now consider Figure A3, which shows the two-dimensional model velocity at the entrance. The baseline velocity is -0.10 m/s. Since the station is at the entrance, there is the influence of the mainstream velocity. This is removed to compare to these results. With this in mind, the peak emptying velocity as the vessel passes (t = 48 minutes) is approximately 0.24 m/s. The maximum fill velocity (t = 53 minutes) is 0.28 m/s. At the completion of one cycle (t = 58 minutes) the velocity is 0.14 m/s directed toward the mainstream.

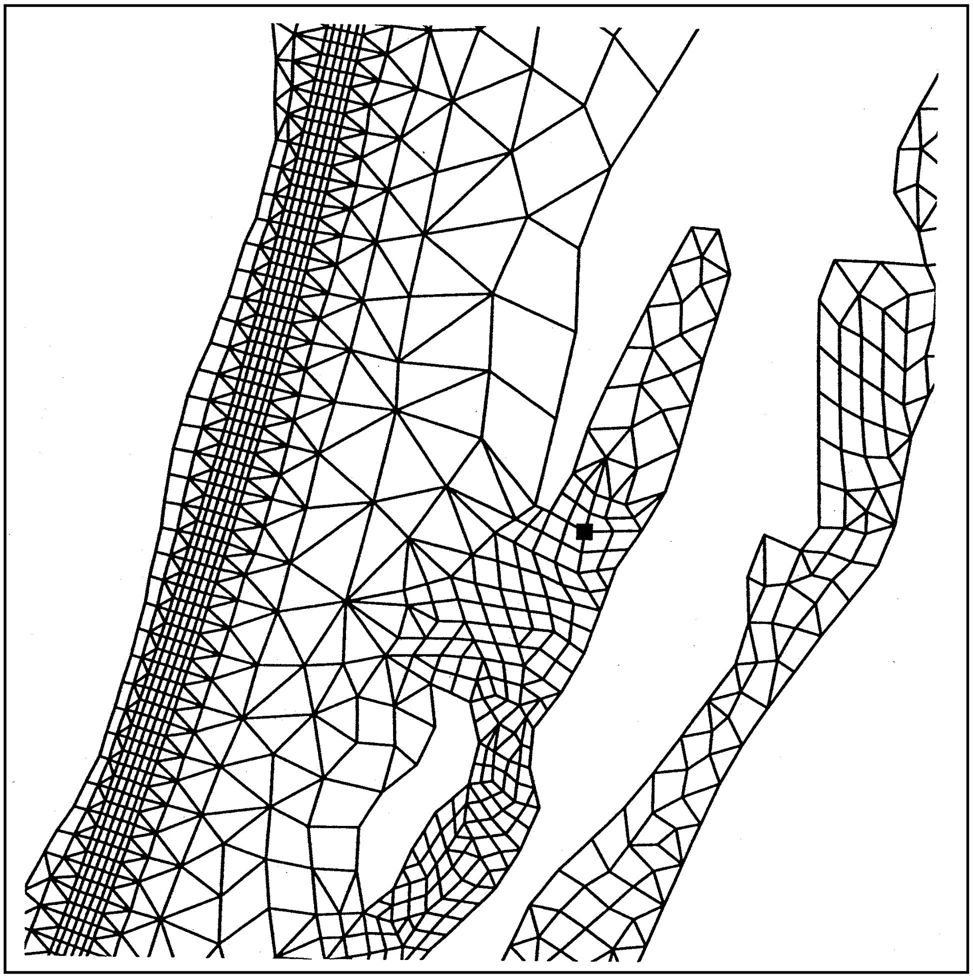


Figure A1. Backwater example on Pool 8, showing the two-dimensional model grid. The dark square indicates the location of Node 8914

Detailed calculations of this example over one complete cycle are presented in the following equations. The calculations proceed by calculating A_{i+1} from A_i where the amplitude A_i is the amplitude before an entrance/exit or before friction loss in a channel. A_{i+1} is afterward.

a. Entrance/exit loss.

$$A_{i+1} = \frac{2H}{\Pi}\left[-1 + \left(1 + \frac{\Pi}{H}A_i\right)^{1/2}\right] \qquad \text{(A16)}$$

b. Friction loss over length X.

$$A_{i+1} = A_i - \frac{\gamma K g A_1^2}{1 + \gamma A_i}X \qquad \text{(A17)}$$

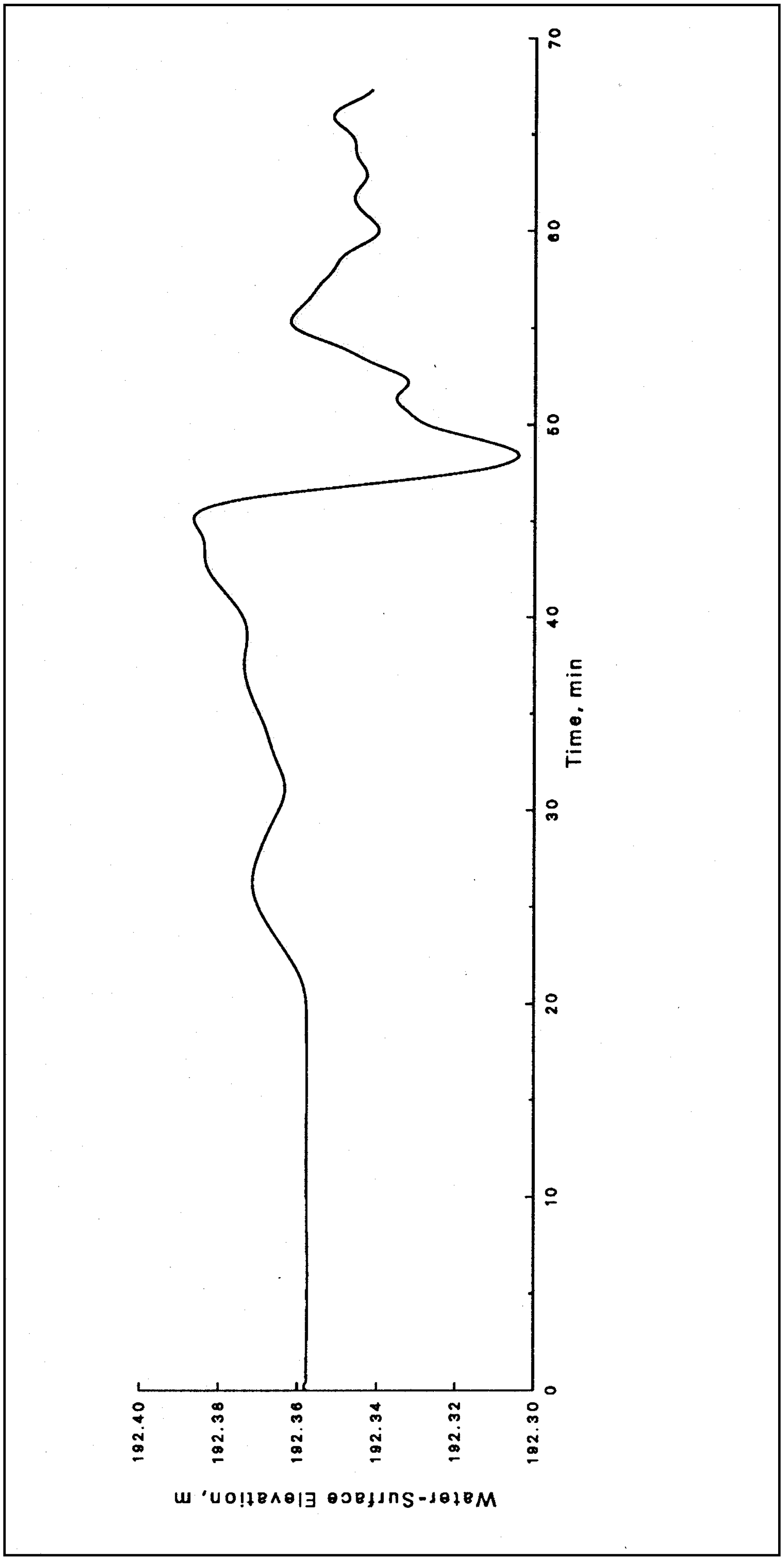


Figure A2. Backwater example water-surface elevation at Pool 8, Node 8914, of the two-dimensional model

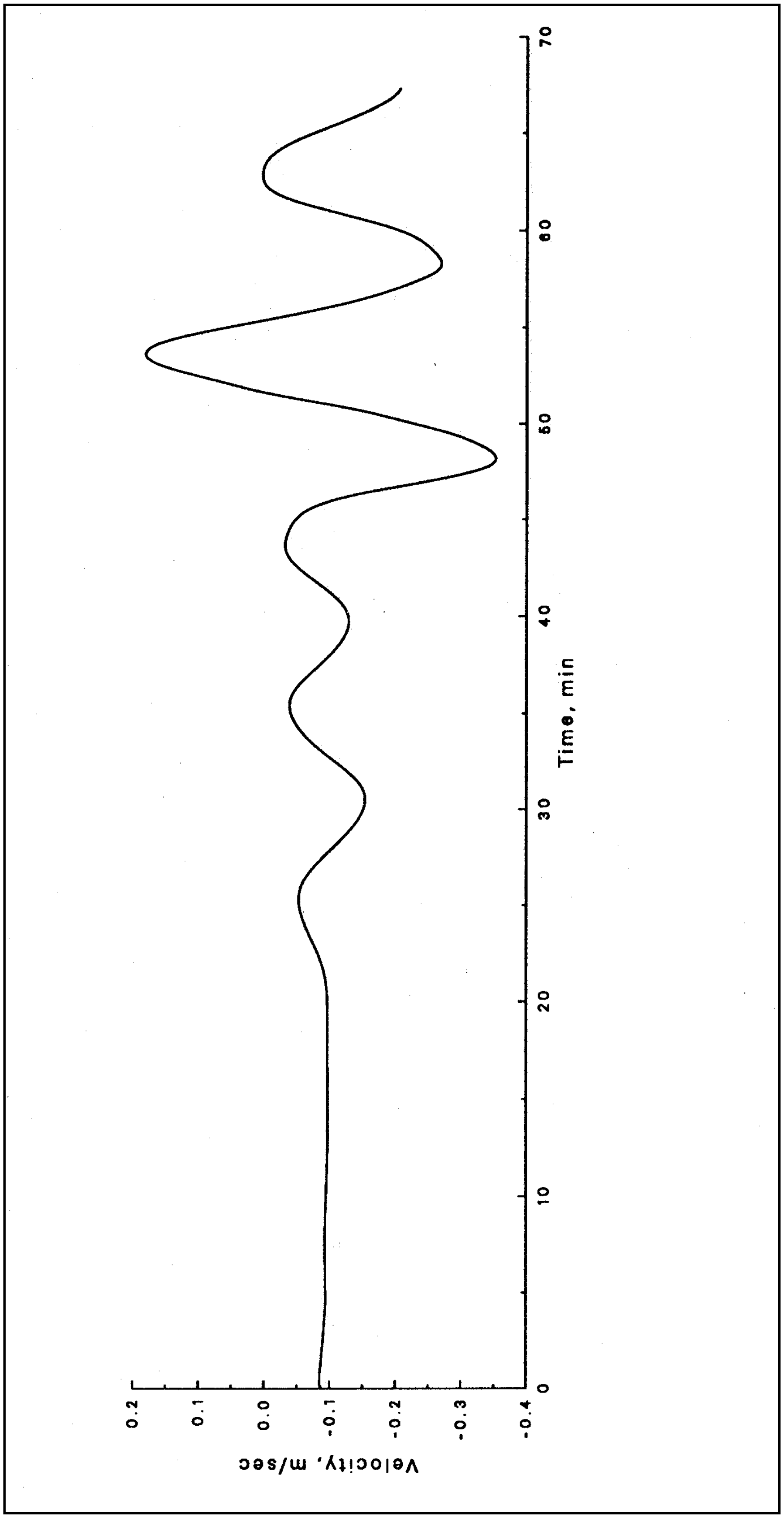


Figure A3. Backwater example velocity (negative velocity is outflow) at Pooi 8, Node 8914, of the two-dimensional model

The Pool 8 example uses these input parameters:

a. Average inlet depth $H = 0.6$ m

b. Channel length $L = 370$ m

c. Hydraulic radius $R = 0.6$ m

d. Cross-sectional area $A = 60.0$ m^2

e. Length of the vessel $L_b = 237.7$ m

f. Vessel speed $V_b = 3.1$ m/s

Manning's n = 0.020. The period is given as twice the time required for the vessel length to pass the entrance, $T = 2L_b/V_b = 153.4$ seconds.

a. Initial amplitude: $A_o = 0.060$ m.

b. After entrance (entrance loss):

$$A_1 \;=\equiv \frac{2H}{\Pi\equiv}\left[-1 + \left(1 +\equiv \frac{\Pi\equiv}{H} A_o\right)^{1/2}\right]$$

$$=\equiv \frac{(2)(0.6)}{\Pi\equiv}\left[-1 + \left(1 +\equiv \frac{\Pi\equiv}{0.6}\, 0.060\right)^{1/2}\right]$$

$$A_1 = 0.056\,\text{m}$$

c. Traversing up the channel to the closed end and back to the entrance friction loss gives

$$A_2 = A_1 - \frac{\gamma K g A_1^2}{1 + \gamma A_1} X$$

$$X = 2 \times 370 = 740\,\text{m}$$

$$\gamma = \frac{\Pi}{4H} = \equiv \frac{\Pi}{(4)\,(0.6)} = 1.31$$

$$K = \left(\frac{n}{C_o R^{2/3}}\right)^2 = \left(\frac{0.020}{(1)\,(0.6)^{2/3}}\right)^2 =$$

$$A_2 = 0.056 - \frac{(1.31)(7.90 \times 10^{-4})(0.056)^2}{1 + (1.31)(0.056)}(740)$$

$$A_2 = 0.034$$

d. Exit loss: $A_3 = 0.033$

e. Entrance loss: $A_4 = 0.031$

f. Channel length twice: $A_5 = 0.024$

g. Exit loss : $A_6 = 0.023$

h. Entrance loss : $A_7 = 0.022$

In order to have any meaningful comparisons the velocity at the entrance should be compared. The peak velocity is found by multiplying the amplitude by $(g/H)^{1/2}$. The initial exit velocity peak is $(g/H)^{1/2} A_1$, $V_1 = 0.23$ m/s. The peak inflow velocity uses the amplitude A_4, but since this is now the superposition of an exiting negative wave and entering positive wave, the velocity magnitude will double, $V_4 = 2(g/H)^{1/2} A_4$, $V_4 = 0.25$ m/s. The next peak velocity occurs for outgoing flow, $V_7 = 2(g/H)^{1/2} A_7$, $V_7 = 0.18$ m/s. Table A1 shows a comparison of peak velocity at the entrance for each wave reflection for the modeled result and by this semi-analytic description.

Table A1
Peak Velocities, m/s, from Pool 8 as Modeled and Using the Semi-analytic Description

Velocity	Model	Semi-Analytic
V_o	-0.24	-0.23
V_4	+0.23	+0.25
V_7	-0.17	-0.18

Secondary Channel

The example of the secondary channel is shown in Figure A4. Results at the upstream inlet are shown in Figure A5 for water surface and Figure A6 for velocity. The behavior of a secondary channel is different from that of a backwater. A backwater is approximated as a channel with a reservoir at the entrance and a closed end. The elevation is dictated at the reservoir, and the velocity (zero velocity) is dictated at the closed end. A secondary channel is approximated as a channel with a reservoir at each end. The initial vessel-induced depression enters at an inlet causing flow out of the channel. When the flow reaches the opposite end of the secondary channel, referred to as the outlet, the elevation cannot be changed. Therefore a positive wave will enter the outlet to cancel the negative wave approaching from the channel. The velocity will double as a result and will be directed into the channel. This wave will then propagate back to the inlet and start another cycle. The period in this case then is $2L/c$. The waves originating from the passage of the vessel produce velocities directed toward this inlet even after reflections. Eventually the vessel passes the outlet and produces velocity pulses directed in the opposite direction. These tend to cause destructive superposition with the inlet-generated wave, resulting in very small currents. It should be noted that the water surface within the interior might experience some larger variations from constructive superposition.

In this particular case in Pool 8, the simple description of a straight prismatic channel, as used in the backwater example, is not very accurate. The two connections are different sizes and there is a third opening into a backwater region. Nevertheless, these are typical conditions and the proposed method will be compared to these results.

The Pool 8 example uses the following input parameters:

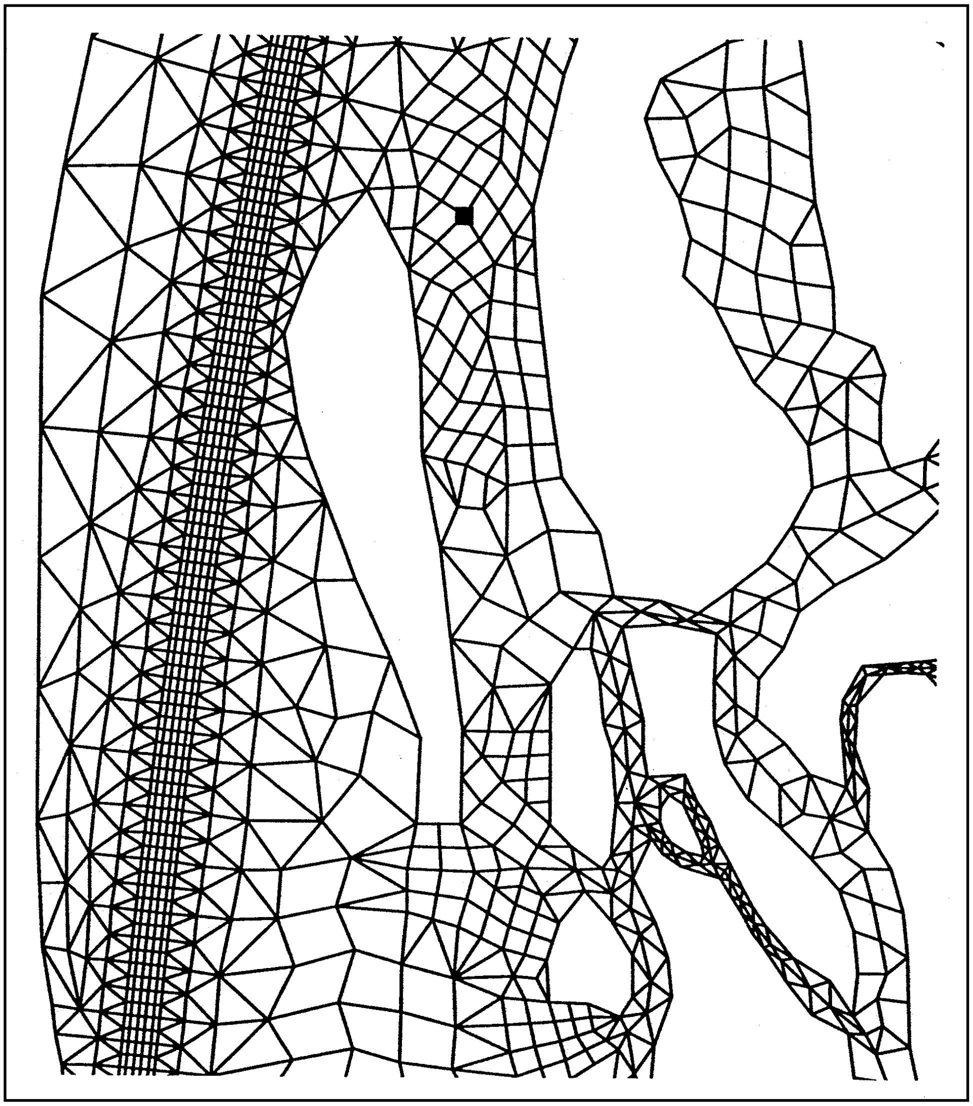


Figure A4. Side channel example on Pool 8, showing the two-dimensional grid. The dark square indicates the location of Node 6038

a. Average inlet depth H = 1.5 m.

b. Channel length L = 700 m.

c. Hydraulic radius R = 1.46 m.

d. Cross-sectional area A = 180.0 m^2.Length of the vessel L_b = 237.7 m.

e. Length of the vessel L_b = 237.7 m.

f. Vessel speed V_b = 3.15 m/s.

The period describing the waveform is approximately twice the time required for the vessel length to pass the entrance, $T = 2L_b/V_b$ = 150.9 seconds.

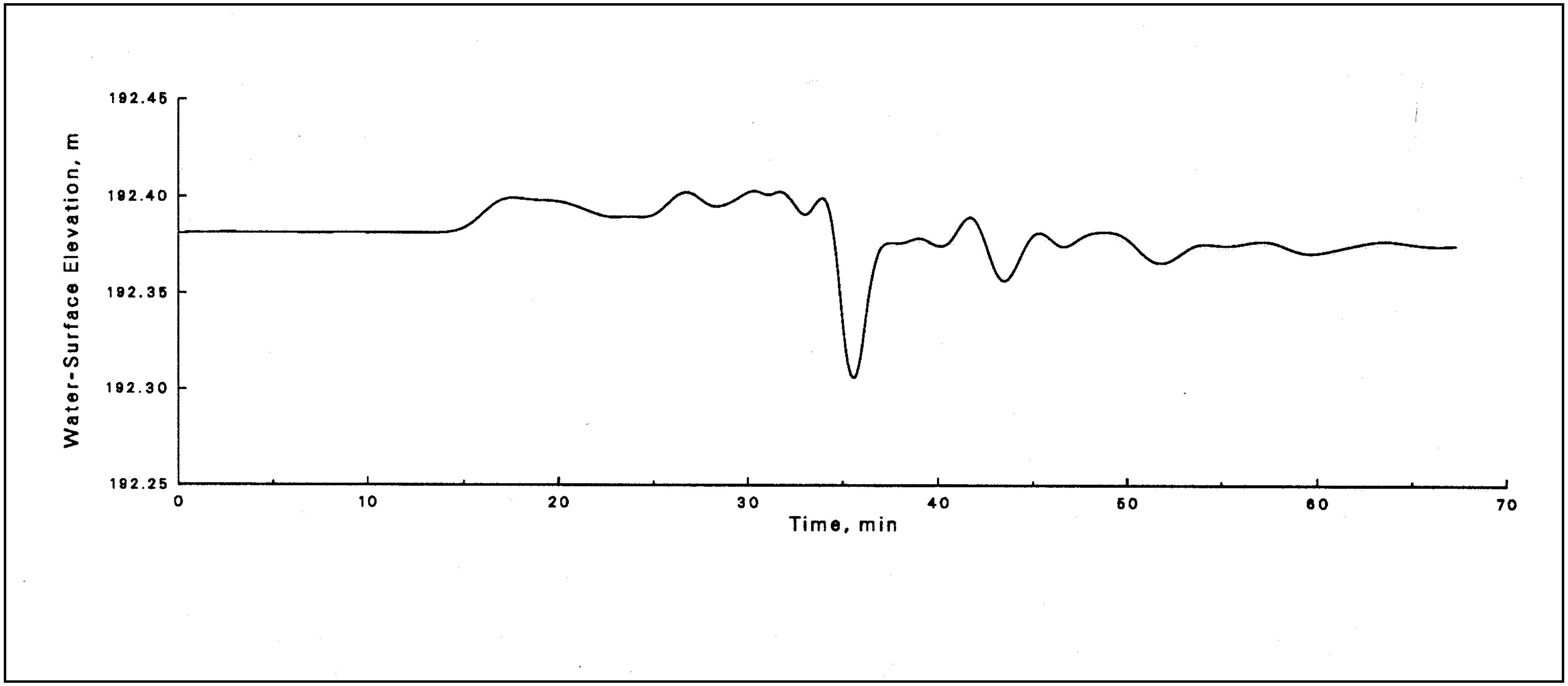


Figure A5. Side channel example for Pool 8 showing water-surface elevation at Node 6038 of the two-dimensional model

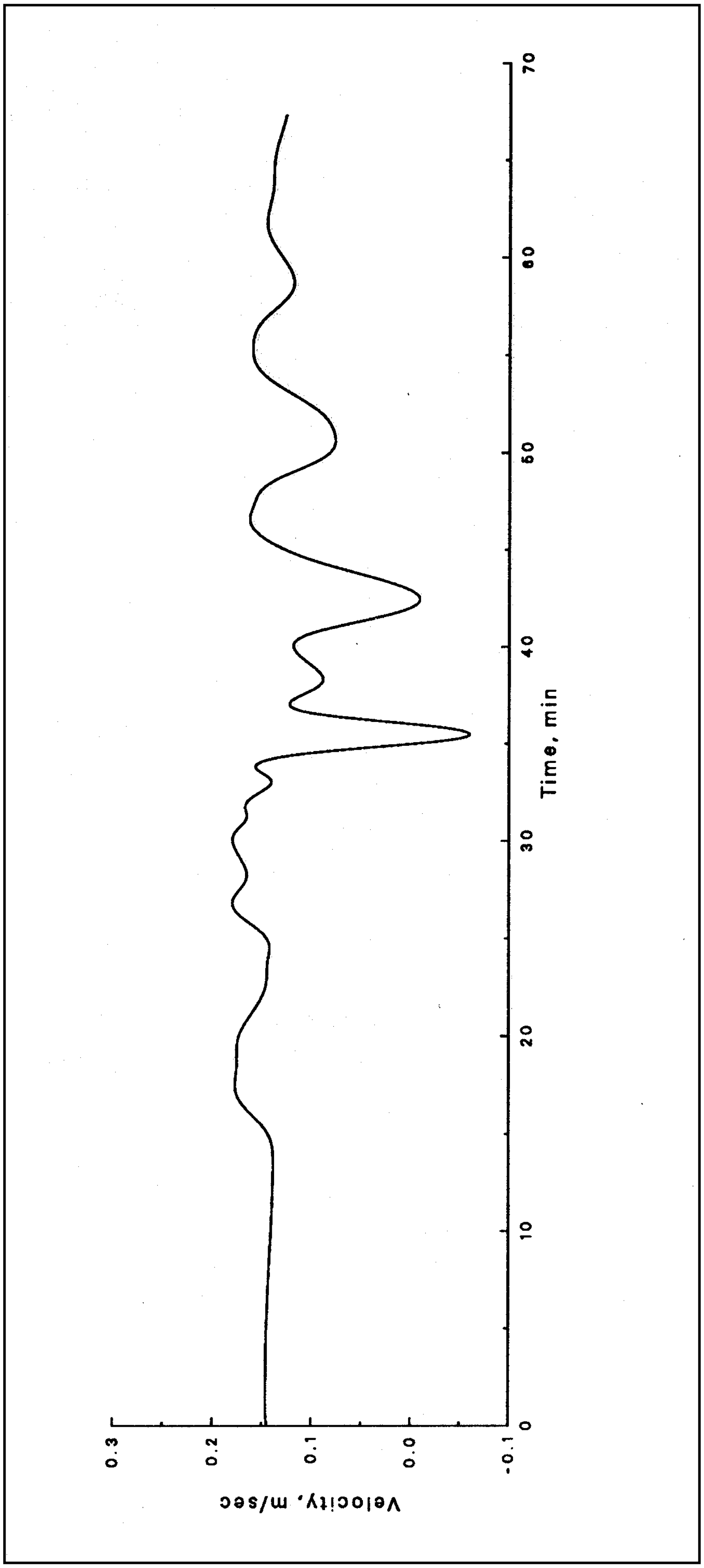


Figure A6. Side channel example for Pool 8 showing velocity at Node 6038 of the two-dimensional model *a.* Initial amplitude:

$$A_o = 0.070\,\text{m}$$

b. Entrance loss:

$$A_1 =\equiv \frac{2H}{\Pi\equiv}\left[-1 + \left(1 +\equiv \frac{\Pi\equiv}{H} A_o\right)^{1/2}\right]$$

$$=\equiv \frac{(2)\ (1.5)}{\Pi\equiv}\left[-1 + \left(1 +\equiv \frac{\Pi\equiv}{1.5}\ 0.070\right)^{1/2}\right]$$

$$A_1 = 0.068$$

c. Friction loss of the channel length:

$$A_2 = A_1 - \frac{\gamma K g A_1^2}{1 + \gamma A_1} X$$

$$X = 700\,m$$

$$\gamma = \frac{\Pi}{4H} = \equiv \frac{\Pi}{(4)\ (1.5)} = 0.524$$

$$K = \left(\frac{n}{C_o R^{2/3}}\right)^2 = \left(\frac{0.0200}{(1)\ (1.5)^{2/3}}\right)^2 = 2.33 \times 10^{-4}$$

$$A_2 = 0.068 - \frac{(0.524)\ (2.33 \times 10^{-4})\ (9.8)\ (0.068)^2}{1 + (0.524)\ (0.068)} 700$$

$$A_2 = 0.064$$

d. Exit loss: $A_3 = 0.062$.

e. Entrance loss: $A_4 = 0.060$.

f. Friction loss: $A_5 = 0.057$.

g. Exit loss: $A_6 = 0.055$.

h. Entrance loss: $A_7 = 0.054$.

This completes one cycle. In this particular case the vessel speed is fast enough that the bow of the vessel reaches the outlet at about the same time that the inlet generated peak does. This provides destructive interference that likely diminishes the velocity magnitude even at one cycle and obviously does for any further cycles. Table A2 shows a comparison of the

Table A2
Comparison of Two-Dimensional Model Results of Velocity at the Inlet and this Simple Calculation, m/s

Velocity	Model	Semi-Analytic
V_o	-0.20	-0.18
V_7	-0.16	-0.28

two-dimensional model results of velocity at the inlet and that of this simple calculation. The initial velocity is simply $V_o = (g/H)^{1/2} A_o = 0.18$ m/s. At the end of one cycle this velocity is doubled due to reflection and is $V_7 = 2\ (g/H)^{1/2} A_7 = 0.28$ m/s.

The two-dimensional model currents in Figure A6 include a steady-state velocity of 0.14 m/s that must be considered.

These vessel-induced currents are found as the difference from the steady-state velocity. The comparison here has less agreement than for the backwater case. There are at least two reasons that this is apparent. First, the vessel-generated wave at the outlet interferes with that generated at the inlet. And secondly, the secondary channel example has many geometric irregularities. The channel is far from uniform and it has a channel branch. Therefore, the calculations from this method overestimate the impact of the vessel.

The volume of water exchanged during the vessel passage is found by integrating the velocity over the deflection period.

$$Vol_i = C_A A_i \left(\frac{g}{H}\right)^{1/2} \frac{T}{\Pi} \qquad \text{(A18)}$$

where

C_A = cross-section area

V_D = volume

This is the volume either entering or leaving during a wave period. The actual volume that is exchanged per cycle is then found as the sum of Vol_1 and Vol_4 for both backwaters and secondary channels.

Implementation

These descriptions have been programmed and tested. The program for the backwaters and secondary channels was used in conjunction with routines and data sets developed to estimate the sedimentation impact of navigation on the Upper Mississippi River and the Illinois Waterway. These backwater and secondary channel calculations were used to provide a coarse screening of areas that may be affected by navigation. As such, some simplifications are necessary. It was assumed that three cycles would occur in each backwater or secondary channel. In reality, the channels are so irregular that often even one complete cycle is difficult to discern. However, three cycles will tend to be a cautious estimate. Flow through the secondary channels due to the steady river flow often is much larger than the vessel-induced currents, so that many times passage of the vessel will not result in flow going into the secondary channel at the inlet side. Even if the vessel passage at the outlet does increase the flow into the inlet, it will not be at the time that the concentrations have been increased due to the vessel passage. Therefore, a conservative simplification that considers only the inlets was made, but used flow volumes calculated as being into the secondary channel. The total flow that should enter the backwater or secondary channel per cycle is treated as an average inflow over that time period and was used later for calculations of sediment mass reaching the embayment.

Summary

This appendix details an approach to estimate the vessel-induced flow exchange into backwaters and secondary channels. This estimate was used in conjunction with several other programs to provide a screening tool that can discern areas that might suffer environmental stress as a result of increased navigation on the Upper Mississippi River and the Illinois Waterway. The movement of a vessel causes a drawdown in the water surface around the vessel. As the vessel passes along the waterway, this moving depression in the water surface causes a wave to propagate into backwaters and secondary channels. If the reflection and friction losses are fairly small, these channels will see these waves bounce back and forth, reflecting off the ends of the channels. Open ends cause a water-surface reflection that is the opposite of the approach wave (or negative reflection); i.e., a depression in the water surface is reflected as a positive wave or surge. At closed ends the wave is reflected positively; i.e., a depression is reflected as a depression. Large variations in wave height then may occur at the closed end and large velocities may occur at open ends. These reflections have a period of roughly $4L/c$ and $2\ L/c$ for backwaters and secondary channels, respectively.

The method outlined is based upon the linearized shallow-water equations. It then uses empirical entrance/exit loss and friction relationships to account for the wave damping. Volume exchange over three cycles is assumed, which should be a conservative estimate since in most cases the wave is damped more quickly. This exchange is then approximated as a flow into the backwater or secondary channel as a constant value over each cycle. This information along with any flow through is used with other programs that estimate drawdown and vessel-induced sediment concentrations to provide a calculation of sediment mass reaching the backwaters and secondary channels.

Appendix B Comparison of Median versus Average Rollup Values

Introduction

As the computations proceeded to compute the volume of sediment delivered to backwaters and secondary channels, the rollup of the 108 tow configurations was one of the required initial input parameters. The rollup of the probabilities was based on the tow configurations, flows, and sailing line locations. For all of the computations used in this report, the 50 percent or median value was used. Based on the unknowns involved in making long-term predictions, it was thought that using the 50 percent value represented a reasonable mix of various tow configurations and normal, overall impacts. Those unknowns are parameters such as actual stage and discharge hydrographs that will occur in the future, exact tow configuration operating in any one pool for a particular month, and long-term changes in ambient sediment concentrations in the rivers.

While this comparison was not a sensitivity analysis in the usual sense, it was undertaken to determine the potential impact on the backwater and secondary channel sedimentation study. Therefore, the two methods considered were based on using the 50 percent probability and the average rollup.

Methodology

The monthly values used for the rollup were initially obtained by sampling the 108 tow configurations 5,000 times. The 5,000 samples took into account the percentage of time that historically the flow was in high, medium, and low conditions for that particular month and the sailing line location with tows being on the right and left sailing line 5 percent of the time each and on the middle sailing line 90 percent of the time. Using the 5,000 tows, 11 probability values of the sediment resuspended by the tows in kilograms/tow were established from percentages of zero to 100 percent in 10 percent increments. This was done for each month of the navigation season for each NAVEFF cell that had been determined to be associated with a backwater or secondary channel inlet. These 11 values defined the probability of exceedance by a single tow, with the median value defined by the 50 percent increment. Once the 50 percent rollup value was determined, it was multiplied times the projected number of tows in that pool in that month for that NAVEFF cell. This was done for all months and then accumulated for a yearly total to determine sediment delivered to a backwater or secondary channel inlet in one year. This accumulated volume was assumed to be retained in the backwater or secondary channel and not subjected to scour.

Recomputation of all of the trend pool sediment quantities using the average rollup would be quite a lengthy process and would mean that essentially all of the trend pool computations starting with the NAVSED program would have to be redone. Therefore, it was decided that the backwaters in Pool 13 of the Mississippi River would be addressed and compared, and then the results from that analysis would be projected to the other trend pools.

Results

The average rollup was obtained by sampling the same tow configuration, flow conditions, and sailing line locations 5,000 times and computing the arithmetic average of the 5,000 events. Depending on the skewness of the distribution, the load computed in kilograms per tow for the average rollup was from slightly greater than a factor of 1 to many times the median rollup value. The interesting point in comparing the average and median rollups was that sediment loadings for NAVEFF cells that had significant sediment loadings with the median rollup were increased by a factor of generally less than 1.5 for the average rollup. This indicates that the median rollup for cells receiving sediments due to tow resuspension included a reasonable amount of the impacts from the tows that created the greatest potential impacts. The average rollup cells, which increased by a factor of more than 5, were the cells that had very small amounts, based on the median rollup. While the average rollup in those cells may have had sediment loadings 5, 10, or 15 times the median rollup loadings, the average rollup loadings and sediment delivered to backwaters were still insignificant.

In Pool 13 of the Mississippi River the same NAVEFF cells for the backwater inlets used with the median rollup were used for the recomputations of the average rollup. Therefore, the load to each backwater inlet, in acre-feet/year, and the sediment delivered, in cm/year, were recomputed based on the arithmetic average of the 5,000 combinations of tows, flows, and sailing line locations for each month. The computations were made for the year 2000 without-project conditions and the year 2050 for Alternative J. The traffic levels for those conditions were significantly different with 2,361 tows versus 3,250 for the without-project and Alternative J, respectively. Then the comparisons of the median (50 percent) and average rollups were made. The results are presented in Table B1.

In the year 2000 without-project, the load into most of the backwater inlets was greater using the average rollup values versus the median (50 percent) rollup values (compare Columns 4 and 7 of Table B1). Likewise the sediment delivered to entire backwaters also increased when the average rollup is compared to the median rollup (compare Columns 5 and 8 of Table B1). As far as projected impacts are concerned, using the average rollup value instead of the median

TABLE B-1. SEDIMENTS TO BACKWATERS, MISSISSIPPI RIVER POOL 13

			WITHOUT PROJECT						ALTERNATIVE J					
			USING 50% ROLLUP			USING AVERAGE ROLLUP			USING 50% ROLLUP			USING AVERAGE ROLLUP		
			YEAR 2000 - 2,361 TOWS			YEAR 2000 - 2,361 TOWS			YEAR 2050 - 3,280 TOWS			YEAR 2050 - 3,280 TOWS		
BW Number	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
BW1	746	cohesive-med	0.0007	0.00003	BLUE	0.0091	0.00047	BLUE	0.0010	0.00004	BLUE	0.0126	0.00065	BLUE
BW1			0.0000			0.0023			0.0000			0.0032		
BW2	33	noncohesive	0.0039	0.00358	BLUE	0.0179	0.01653	BLUE	0.0054	0.00497	BLUE	0.0249	0.02300	BLUE
BW3	83	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW4	876	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW4			0.0000			0.0000			0.0000			0.0000		
BW5	782	cohesive-med	0.0000	0.01984	BLUE	0.0003	0.04484	BLUE	0.0000	0.02758	BLUE	0.0004	0.06230	YELLOW
BW5			0.3236			0.8181			0.4496			1.1366		
BW5			0.1849			0.3264			0.2569			0.4535		
BW5			0.0007			0.0057			0.0010			0.0080		
BW6	934	cohesive-soft	0.4754	0.01552	BLUE	1.0127	0.03305	YELLOW	0.6605	0.02155	BLUE	1.4069	0.04591	YELLOW
BW7	399	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW7			0.0000			0.0000			0.0000			0.0000		
BW7			0.0000			0.0000			0.0000			0.0000		
BW7			0.0000			0.0000			0.0000			0.0000		
BW7			0.0000			0.0000			0.0000			0.0000		
BW9	127	cohesive-med	0.0008	0.00020	BLUE	0.0033	0.00079	BLUE	0.0011	0.00027	BLUE	0.0046	0.00110	BLUE
BW10	1181	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00013	BLUE	0.0000	0.00000	BLUE	0.0000	0.00018	BLUE
BW10			0.0000			0.0000			0.0000			0.0020		
BW10			0.0000			0.0002			0.0000			0.0067		
BW10			0.0000			0.0048			0.0000			0.0000		
BW10			0.0000			0.0000			0.0000			0.0000		
BW11	1122	cohesive-soft	0.0132	0.45104	YELLOW	0.0163	0.58152	YELLOW	0.0184	0.62653	YELLOW	0.0226	0.80782	YELLOW
BW11			0.0106			0.0125			0.0147			0.0174		
BW11			0.3117			0.5691			0.4329			0.7906		
BW11			0.3414			0.6176			0.4741			0.8579		
BW11			0.2089			0.2545			0.2902			0.3535		
BW11			4.0602			5.3116			5.6397			7.3786		
BW11			11.6572			14.6246			16.1933			20.3161		

Note: To convert acres to square meters, multiply by 4,046.873. To convert acre-ft/year to cu m/year, multiply by 1,233.49.

value for the year 2000 without project tow projections caused one Pool 13 backwater, BW6, to be classified as having a medium (YELLOW) impact instead of a negligible (BLUE) impact. The change was based on the sediment load at the backwater inlet increasing from 0.4754 acre-ft/year (586.4 cu m/year) to 1.0127 acre-ft/year (1,249.2 cu m/year). This raised it above one of the levels of significance presented in this report.

In the year 2050 for Alternative J traffic projects, the same trend was determined using the average and median rollup values. The sediment load into each backwater inlet was greater (compare Columns 10 and 13 of Table B1) and the backwater annual sediment delivery rate was also greater (compare Columns 11 and 14 of Table B1) with the average rollup value. Again it was BW6 that showed a change in potential impact with sediment load into the one backwater inlet increasing from 0.6605 to 1.4089 acre-ft/year (814.7 to 1,737.9 cu m/year). No additional backwater inlets or backwaters were indicated as having an impact using the average rollup value different from what was calculated using the median rollup value.

A review of Table B1 indicates that for inlets that had some “meaningful” quantity of sediment load using the 50 percent rollup value, the average rollup value was not significantly greater. Here “meaningful” could be defined as a sediment load of 0.01 acre-ft/year (12.3 cu m/year) or greater. For example, the second backwater inlet to BW11 (Table B1) had a median value in the year 2000 of 0.0106 acre-ft/year (13.07 cu m/year). Using the average rollup for the year 2000 increased the load to 0.0125 acre-ft/year (15.4 cu m/year). That indicates about an 18 percent increase in sediment load. However, in inlets with less than the “meaningful” load, such as the first inlet to BW1 or the inlet to BW2, there were significantly greater increases in percentage. The first inlet to BW1 went from 0.0007 acre-ft/year (0.86 cu m/year) (using median rollup in the year 2000) to 0.0091 acre-ft/year (11.2 cu m/year) (using the average rollup in the year 2000). That is an increase by a factor of about 13. However, even the average rollup produced a value much lower than the level of significance used in the evaluation. In the case of the inlet to BW2, the sediment load for the median rollup produced a sediment load of 0.0039 acre-ft/year (4.8 cu m/year), which increased to 0.0179 acre-ft/year (22.08 cu m/year) for the average rollup. That is an increase by a factor of about 4.5, but the higher value remained well below the level of significance.

The explanation for these observations determined from Table B1 is that the median rollup value tended to focus on the inlets with the largest sediment resuspension values due to the tow configurations, flow, and sailing line location. By using the average rollup, what is included in the resuspension values are the limited number of tow configurations, flow conditions, and sailing line locations that could potentially produce extremely high concentrations. Since such situations are very unusual, their impacts show up at inlets that had relatively small values using the median rollup. The inlets with larger amounts of sediment using the median rollup value have a significant amount of sediment introduced into them on a yearly basis, so adding some highly unusual situations does not significantly increase the total yearly sediment loads.

Application to Other Mississippi River Trend Pools

Using the increases from the year 2000 median to average rollups without project and the Alternative J year 2050 median to average rollups, it was determined that it would be reasonable to expect that the average rollup would increase the median rollup value by a factor of about 3.3. That factor was then applied to the inlet sediment loads and the volume of sediment delivered to backwaters or secondary channels in the Mississippi River trend pools. The analysis was based on the year 2050 for Alternative J as presented in the main text of this report (Tables 4, 5, 6, 8, 9, and 10). Two separate issues were considered – inlets and areas (backwaters or secondary channel). This approach was taken since in the previous determination of significance it was determined that if one inlet to a backwater had a medium (YELLOW) or high (RED) potential for impact, then the entire backwater was indicated as having that impact potential. Therefore, the values were reviewed based on these criteria. Also, if an inlet, backwater, or secondary channel had already been identified as having a medium (YELLOW) impact potential, it was evaluated for the possibility of going to a high (RED) potential based on the average rollup. This issue was addressed since in the previously conducted analysis using the median (50 percent) rollup, there were no inlets or areas with high impact potential in the Mississippi River trend pools and to ensure that this new comparison has the potential to identify high-impact areas.

Table B2 presents the results of applying the average rollup to the backwaters and secondary channels in the Mississippi River trend pools. It should be noted that going from using the median rollup value to the average rollup value did not change any inlets, backwaters, or secondary channels previously determined to have medium (YELLOW) impact potential to a high (RED) potential.

Pool 4

In Pool 4, 16 inlets and 10 backwaters were identified (Table 4). In the previous analysis using the median rollup value all inlets and backwaters were designated as having negligible potential for impacts from sediment resuspension from towboats. When the average rollup value was applied to Pool 4, all 16 inlets and 10 backwaters remained as having negligible (BLUE) impact potential (Table B2).

Pool 8

In Mississippi River trend Pool 8, 15 inlets and 5 backwaters were previously addressed (Table 5). As presented in the main body of this report, one of the inlets to BW2 and the backwater itself exceeded the level of significance for impacts and was designated as having a medium (YELLOW) impact potential based on the median rollup. Using the average rollup value added the second inlet to BW6 and the backwater from the negligible (BLUE) impact category to

Table B2 Potential Impacts for Alternative J								
			Based On Average Rollup					
					Additional Inlets		Additional Areas	
Pool	Attribute	Total Inlets & Areas	Number of Blue Inlets	Number of Blue Areas	Inlets to Yellow	Yellow/Total (%)	Areas to Yellow	Yellow/Total (%)
4	Backwaters	16 & 10	16	10	0	0	0	0
8	Backwaters[1]	15 & 5	12	3	1	7	1	20
8	Secondary Channels	8 & 8	7	7	1	13	1	13
13	Backwaters[2]	29 & 10	20	7	2	7	2	20
13	Secondary Channels[3]	12 & 12	10	10	0	0	0	0
26	Backwaters	12 & 9	12	9	0	0	0	0
26	Secondary Channels	10 & 8	10	8	0	0	0	0
All Backwaters and Secondary Channels		102 & 62	87	54	4	4	4	6

[1] One backwater with 2 inlets was designated as medium (YELLOW) potential impacts using the median rollup.
[2] One backwater with 7 inlets was designated as medium (YELLOW) potential impacts using the median rollup.
[3] Two secondary channels with 1 inlet each were designated as medium (YELLOW) potential impacts using the median rollup.

the medium (YELLOW) impact potential. This meant that one inlet out of a total of 15, or 7 percent, and one backwater out of a total of 5, or 20 percent, would have an impact greater than negligible using the average rollup value. Of the 8 secondary channel inlets and channels, the median rollup value produced all negligible impact potential for Alternative J (Table 6). By using the average rollup value the inlet to SEC8 and the secondary channel would exceed the levels of significance for sediment load and sediment delivered, and SEC8 would change to a medium impact potential. This meant that one inlet out of a total of 8, or 13 percent, and one secondary channel out of a total of 8, or 13 percent, would have a medium (YELLOW) impact potential based on the average rollup. The overall changes to Pool 8 backwaters and secondary channels are presented in Table B2.

Pool 13

Table B1 indicated that the 10 backwaters in Pool 13 had 29 inlets. The actual computations showed that using the average rollup changed two inlets and two backwaters from negligible (BLUE) impact potential to medium (YELLOW) impact potential. This meant that 7 percent of all the inlets and 20 percent of all the backwaters in Pool 13 would be changed if the average rollup instead of the median rollup were used. In Pool 13, 12 inlets and secondary channels were identified in the analysis (Table 8). Two of those inlets and secondary channels were determined to have medium impact potential using the median rollup value. Using the average rollup value provided no additional inlets or backwaters (Table B2).

Pool 26

In Pool 26, 12 inlets (Table 9) feed a total of 9 backwaters. Using the average rollup value rather than the median value produced no changes for any inlets or backwaters from negligible to medium impact potential. The 8 secondary channels in Pool 26 have a total of 10 inlets. Again applying the average rollup value to these inlets and secondary channels produced no changes from negligible to medium impact potential (Table B2).

Summary

When all of the Mississippi River trend pool backwaters, secondary channels, and their associated inlets are considered, the overall effects of using the average rollup value rather than the median (50 percent) rollup value appears to be rather insignificant. As shown in Table B2, of the total 102 inlets and 62 backwaters or secondary channels identified, using the average instead of the median rollup moved 4 inlets and areas (either backwaters or secondary channels) into the medium (YELLOW) impact potential range. This means that 4 percent of all the inlets and 6 percent of the identified areas could be impacted by significantly changing the methodology in evaluating the effects of tow-induced sedimentation into backwaters and secondary channels.

Use of the average rollup probably is the more realistic of the two methods considered thus far. However, there is a measure of uncertainty in input parameters such as the exact tow configurations that may pass through any given pool in the future, the discharge and stage hydrographs that may occur in the future, and the traffic projections for each pool in the future. The uncertainty of these three parameters in concert with many of the assumptions and reasoning applied to the various programs (NAVEFF, NAVSED, and BACKSED) used to compute the trend pool quantities ends up creating a situation that is a reasonable engineering judgment, but not the perfect answer. As the extrapolation of the nontrend pools progressed, at times it became a matter of judgment as to the potential for impact. The researchers making those determinations always tended to give the benefit of the doubt to some impact, instead of a negligible impact. Therefore, the projections made to date are reasonable and defensible, but subject to refinement in the future.

Appendix C Recomputation of Potential Impacts Based on Revised Traffic

Introduction

As the Upper Mississippi River and Illinois Waterway System Navigation Study progressed, the issue relative to the traffic projections was reevaluated using different assumptions from those used originally. The original scenarios and projections were initially used in this report in the computation of sedimentation to backwaters and secondary channels. The Coastal and Hydraulics Laboratory (CHL) of the U.S. Army Engineer Research and Development Center recomputed the tow-induced sedimentation to backwaters and secondary channels with those new traffic projections. The traffic data, which was provided to CHL from the U.S Army Engineer District, Rock Island, is referred to in this analysis as the September 2000 Faucett traffic forecasts or the Faucett traffic scenario.

Faucett Traffic Forecast

When one considers the recomputation and reanalysis of the impacts of towboat navigation on sedimentation into backwaters and secondary channels, it is worth considering the difference in the two traffic scenarios being considered. Table C1 provides a direct comparison for the various plans being considered for the Mississippi River and Illinois Waterway. It should be noted that the various improvements included in each plan are presented in Table 3 of the main report.

A review of Table C1 shows that for all of the trend pools in the year 2000, the original traffic scenario projected higher traffic than the Faucett scenario. In Pools 4 and 8 for the year 2050 in the without-project and all alternative conditions, the Faucett scenario projected higher traffic levels than the original scenario. In Pool 13 for the year 2050 in the without-project and Alternative B conditions, the Faucett scenario also projected traffic levels higher than the original scenario. However, in Pool 13 for the year 2050 with Alternatives E, F, J, K, and L conditions, the Faucett scenario projected lower traffic levels than the

Table C1 Original and September 2000 Faucett Traffic Scenarios											
Plan	Year	Original Projected Traffic (Tows/Year)					September 2000 Faucett Projected Traffic (Tows/Year)				
		Pool					Pool				
		4	8	13	26U/26D[1]	LaGrange	4	8	13	26U/26D[1]	LaGrange
Without Project	2000	1,322	1,609	2,361	3,792/8,589	3,955	1,318	1,588	2,231	3,577/7,876	3,547
Without Project	2050	1,236	1,505	2,451	4,088/11,033	5,633	1,327	1,620	2,483	4,064/10,467	5,303
Alternative B	2050	1,421	1,738	2,768	4,692/11,691	5,634	1,516	1,852	2,784	4,589/11,039	5,309
Alternative E	2050	1,722	2,118	3,277	5,597/12,675	5,634	1,758	2,148	3,163	5,326/11,850	5,313
Alternative F	2050	1,723	2,119	3,278	5,605/13,187	6,173	1,758	2,148	3,163	5,330/11,975	5,446
Alternative J	2050	1,724	2,120	3,280	5,607/13,143	6,124	1,759	2,149	3,165	5,334/12,045	5,517
Alternative K	2050	1,905	2,346	3,576	5,904/13,492	6,120	1,985	2,426	3,522	5,707/12,466	5,514
Alternative L	2050	1,905	2,346	3,576	5,904/13,029	5,632	1,986	2,427	3,522	5,703/12,275	5,312

[1] Pool 26 where 26U is upstream and 26D is downstream of the confluence of the Mississippi River and Illinois Waterway.

original scenario. In the year 2050 in Pool 26 (upstream and downstream of the confluence of the Mississippi River and Illinois Waterway) and the LaGrange Pool on the Illinois Waterway for the without-project and all alternative conditions, the Faucett scenario projected lower traffic levels than the original scenario.

Therefore, as an initial analysis of the potential impacts to backwaters and secondary channel sedimentation, it is obvious that the Faucett scenario would produce increased potential impacts in Pools 4 and 8 in the year 2050 for the without-project and all alternative conditions, and increased potential impacts in Pool 13 for the without-project and Alternative B conditions. For the remainder of the conditions the Faucett scenario projected traffic levels are lower than the original scenario; therefore, there would be a decrease in potential impacts with the Faucett scenario.

Approach

In consideration of the new traffic forecasts, it was decided that the potential impacts to backwaters and secondary channels for the four Mississippi River trend pools and the LaGrange Pool (the Illinois Waterway trend pool) would be completely recomputed. The identical methodology presented earlier in this report was followed to accomplish this new analysis, including the use of the same levels of significance as previously determined. Also, the volume of material entering any of the inlets to a backwater or the inlet to a secondary channel was obtained using the 50 percent rollup value of sediment resuspended in the NAVEFF cell adjacent to each inlet.

Mississippi River Pools

Results in trend pools

Pool 4. The results of the computations using the Faucett traffic scenario for sediment delivered to Pool 4 backwaters are presented in Table C2. Table C2 shows that for the without-project for the years 2000 and 2050 and for Alternatives B, E, F, J, K, and L at the year 2050 the potential of impacts based on sediment delivered to the backwaters was negligible. Therefore, all of the Pool 4 backwaters were again given an impact color of BLUE, just as they had using the original traffic scenario (Table 4). As was discussed previously, the Hydraulic Classification delineated no secondary channels and those attributes were not addressed in Pool 4.

In reviewing Table C2 and Table 4, the reader should be reminded that values of “0.0000” or “0.00000” may be a truncation (numerical rounding) or actually zero depending on the specific NAVEFF cell being used. The point to remember in such circumstances is that the rate at which sediment is delivered is so low that negligible volumes of sediment would enter the backwater or secondary channel through such an inlet.

Pool 8. The results of the computations using the Faucett traffic forecasts for sediment delivered to Pool 8 backwaters are presented in Table C3 and Pool 8 secondary channels in Table C4. As was the case using the original traffic scenarios, BW2 had the potential for medium impacts and was colored YELLOW for all conditions. The remainder of the Pool 8 backwaters have negligible impact potential and were colored BLUE. The without-project for the year 2000 value to BW2 has a sediment load into the backwater of 2.64 acre-ft/year (3,256 cu m/year) (for the first inlet) and a sediment delivery rate of 0.13 cm/year. These values increase to 4.04 acre-ft/year (4,983.3 cu m/year) and 0.20 cm/year in the year 2050 for Alternatives K and L, the highest projected traffic level. This is an increase over the original scenario in the year 2050 for without-project and all alternatives due to the increase in projected traffic for the Faucett forecasts (Table C3 and Table 5). With the Faucett forecasts all of the secondary channels in Pool 8 (Table C4) except SEC8 had negligible sediment delivered to them and have impact color BLUE. Secondary channel SEC8 was YELLOW only for the traffic projected with Alternatives K and L with a value of 0.11 cm/year, which was slightly greater than the established level of significance (0.1 cm/year). With the original traffic scenario SEC8 was determined to have medium potential for impacts only with Alternatives K and L also (compare Table C4 and Table 6).

Pool 13. The Pool 13 results of the computations with the Faucett traffic scenarios of sediment delivered to backwaters are presented in Table C5 and to Pool 13 secondary channels in Table C6. Computations indicate that all backwaters are BLUE with the exception of BW11, which is YELLOW for without-project and all alternatives. For all traffic scenarios the last two inlets to BW11 had annual loads greater than 1.0 acre-ft/year (1,233.5 cu m/year) and sediment delivery rates greater than 0.1 cm/year, but less than 1.0 cm/year. BW8 was not included in the computations because it is part of a game refuge with a levee type structure around it. The Pool 13 secondary channel results using the Faucett traffic projections indicated that 10 of the channels would have negligible impacts and were colored BLUE for all conditions. Two secondary channels, SEC8 and SEC12, were YELLOW for the without-project and all alternatives traffic scenarios. The annual sediment delivery for SEC8 varied from 0.11 cm/year (year 2000, without project) to a high of 0.14 cm/year (year 2050, Alternatives K and L). For SEC12 the annual delivery varied from 0.24 cm/year

TABLE C2. SEDIMENTS TO BACKWATERS, MISSISSIPPI RIVER POOL 4

BASED ON 50% ROLLUP and SEPTEMBER 2000 FAUCETT TRAFFIC FORECAST

			WITHOUT PROJECT						ALTERNATIVE B			ALTERNATIVES E, F, and J			ALTERNATIVES K and L		
			YEAR 2000 -1,318 TOWS			YEAR 2050 - 1,327 TOWS			YEAR 2050 - 1,516 TOWS			YEAR 2050 -1,759 TOWS			YEAR 2050 - 1,986 TOWS		
BW Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
BW1	83	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW2	67	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW3	1345	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW3			0.0000			0.0000			0.0000			0.0000			0.0000		
BW3			0.0000			0.0000			0.0000			0.0000			0.0000		
BW4	178	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW5	31	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW6	71	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW8	145	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW9	2676	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW9			0.0000			0.0000			0.0000			0.0000			0.0000		
BW9			0.0000			0.0000			0.0000			0.0000			0.0000		
BW9			0.0000			0.0000			0.0000			0.0000			0.0000		
BW10	102	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW10			0.0000			0.0000			0.0000			0.0000			0.0000		
BW12	859	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE

Note: To convert acres to square meters, multiply by 4,046.873. To convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] BW7 not included due to presence of tributary. BW11 not included because it is created by a railroad embankment and is adjacent to impounded backwater.

TABLE C3. SEDIMENTS TO BACKWATERS, MISSISSIPPI RIVER POOL 8

BASED ON 50% ROLLUP and SEPTEMBER 2000 FAUCETT TRAFFIC FORECAST

			WITHOUT PROJECT						ALTERNATIVE B			ALTERNATIVES E, F, and J			ALTERNATIVES K and L		
			YEAR 2000 -1,588 TOWS			YEAR 2050 - 1,620 TOWS			YEAR 2050 - 1,852 TOWS			YEAR 2050 - 2,149 TOWS			YEAR 2050 - 2,427 TOWS		
BW Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
BW1	799	noncohesive	0.0001	0.00019	BLUE	0.0001	0.00019	BLUE	0.0001	0.00022	BLUE	0.0001	0.00026	BLUE	0.0001	0.00029	BLUE
BW1			0.0049			0.0050			0.0057			0.0066			0.0074		
BW1			0.0000			0.0000			0.0000			0.0000			0.0000		
BW2	614	cohesive-med	2.6437	0.13128	YELLOW	2.6978	0.13397	YELLOW	3.0827	0.15308	YELLOW	3.5292	0.17525	YELLOW	4.0426	0.20075	YELLOW
BW2			0.0009			0.0009			0.0010			0.0012			0.0013		
BW3	3963	cohesive-med	0.0000	0.00092	BLUE	0.0000	0.00093	BLUE	0.0000	0.00107	BLUE	0.0001	0.00124	BLUE	0.0001	0.00140	BLUE
BW3			0.0644			0.0657			0.0752			0.0872			0.0985		
BW3			0.0067			0.0069			0.0078			0.0091			0.0103		
BW3			0.0000			0.0000			0.0000			0.0000			0.0000		
BW3			0.0002			0.0002			0.0002			0.0002			0.0003		
BW3			0.0478			0.0488			0.0557			0.0647			0.0731		
BW4	631	cohesive-med	0.0233	0.00113	BLUE	0.0238	0.00115	BLUE	0.0272	0.00131	BLUE	0.0316	0.00152	BLUE	0.0356	0.00172	BLUE
BW6	721	noncohesive	0.0000	0.02521	BLUE	0.0000	0.02571	BLUE	0.0000	0.02940	BLUE	0.0000	0.03368	BLUE	0.0000	0.03852	BLUE
BW6			0.5672			0.5785			0.6615			0.7574			0.8668		
BW6			0.0291			0.0297			0.0340			0.0394			0.0445		

Note: To convert acres to square meters, multiply by 4,046.873. To convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] BW 5 not included since it is an Impounded Backwater

TABLE C4. SEDIMENTS TO SECONDARY CHANNELS, MISSISSIPPI RIVER POOL 8																		
BASED ON 50% ROLLUP and SEPTEMBER 2000 FAUCETT TRAFFIC FORECAST														ALTERNATIVES E, F, and J			ALTERNATIVES K and L	
				WITHOUT PROJECT						ALTERNATIVE B								
				YEAR 2000 - 1,588 TOWS			YEAR 2050 - 1,620 TOWS			YEAR 2050 - 1,852 TOWS			YEAR 2050 - 2,149 TOWS			YEAR 2050 - 2,427 TOWS		
SEC Number[1]	WATER AREA (acres)	AVG. DEPTH (ft)	ADJACENT SEDIMENT TYPE	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
SEC1	125	6.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC2	44	3.2	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC3	58	3.1	noncohesive	0.0001	0.00006	BLUE	0.0001	0.00006	BLUE	0.0001	0.00006	BLUE	0.0001	0.00007	BLUE	0.0002	0.00008	BLUE
SEC4	24	5.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC5	88	7.9	cohesive-med	0.0003	0.00011	BLUE	0.0003	0.00012	BLUE	0.0004	0.00013	BLUE	0.0004	0.00015	BLUE	0.0005	0.00018	BLUE
SEC6	33	2.6	cohesive-med	0.0079	0.00733	BLUE	0.0081	0.00748	BLUE	0.0093	0.00855	BLUE	0.0107	0.00993	BLUE	0.0121	0.01121	BLUE
SEC7	25	2.2	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00001	BLUE
SEC8	10	7.5	cohesive-med	0.0233	0.07110	BLUE	0.0238	0.07252	BLUE	0.0272	0.08291	BLUE	0.0316	0.09619	BLUE	0.0356	0.10865	YELLOW
Note: To convert acres to square meters, multiply by 4,046.873; to convert feet to meters, multiply by 0.3048; to convert acre-ft/year to cu m/year, multiply by 1,233.49.																		

TABLE C5. SEDIMENTS TO BACKWATERS, MISSISSIPPI RIVER POOL 13

BASED ON 50% ROLLUP and SEPTEMBER 2000 FAUCETT TRAFFIC FORECAST

			WITHOUT PROJECT						ALTERNATIVE B			ALTERNATIVES E, F, and J			ALTERNATIVES K and L		
			YEAR 2000 - 2,231 TOWS			YEAR 2050 - 2,483 TOWS			YEAR 2050 - 2,784 TOWS			YEAR 2050 - 3,165 TOWS			YEAR 2050 - 3,522 TOWS		
BW Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
BW1	746	cohesive-med	0.0007	0.00003	BLUE	0.0007	0.00003	BLUE	0.0008	0.00003	BLUE	0.0009	0.00004	BLUE	0.0011	0.00004	BLUE
BW1			0.0000			0.0000			0.0000			0.0000			0.0000		
BW2	33	noncohesive	0.0036	0.00336	BLUE	0.0040	0.00373	BLUE	0.0045	0.00418	BLUE	0.0051	0.00476	BLUE	0.0057	0.00529	BLUE
BW3	83	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW4	876	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW4			0.0000			0.0000			0.0000			0.0000			0.0000		
BW5	782	cohesive-med	0.0000	0.01859	BLUE	0.0000	0.02067	BLUE	0.0000	0.02319	BLUE	0.0000	0.02636	BLUE	0.0000	0.02932	BLUE
BW5			0.3031			0.3370			0.3781			0.4297			0.4781		
BW5			0.1732			0.1926			0.2160			0.2455			0.2732		
BW5			0.0006			0.0007			0.0008			0.0009			0.0010		
BW6	934	cohesive-soft	0.4452	0.01453	BLUE	0.4952	0.01616	BLUE	0.5554	0.01813	BLUE	0.6313	0.02060	BLUE	0.7023	0.02292	BLUE
BW7	399	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW7			0.0000			0.0000			0.0000			0.0000			0.0000		
BW7			0.0000			0.0000			0.0000			0.0000			0.0000		
BW7			0.0000			0.0000			0.0000			0.0000			0.0000		
BW7			0.0000			0.0000			0.0000			0.0000			0.0000		
BW9	127	cohesive-med	0.0008	0.00018	BLUE	0.0008	0.00020	BLUE	0.0010	0.00023	BLUE	0.0011	0.00026	BLUE	0.0012	0.00029	BLUE
BW10	1181	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW10			0.0000			0.0000			0.0000			0.0000			0.0000		
BW10			0.0000			0.0000			0.0000			0.0000			0.0000		
BW10			0.0000			0.0000			0.0000			0.0000			0.0000		
BW10			0.0000			0.0000			0.0000			0.0000			0.0000		
BW11	1122	cohesive-soft	0.0124	0.42213	YELLOW	0.0138	0.46951	YELLOW	0.0155	0.52661	YELLOW	0.0176	0.59845	YELLOW	0.0196	0.66596	YELLOW
BW11			0.0099			0.0110			0.0123			0.0140			0.0168		
BW11			0.2923			0.3251			0.3646			0.4144			0.4611		
BW11			0.3202			0.3560			0.3993			0.4539			0.5050		
BW11			0.1955			0.2174			0.2438			0.2771			0.3084		
BW11			3.7980			4.2246			4.7385			5.3846			5.9920		
BW11			10.9109			12.1353			13.6111			15.4679			17.2118		

Note: To convert acres to square meters, multiply by 4,046.873. To convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] BW 8 not included since it is part of a game refuge

TABLE C6. SEDIMENTS TO SECONDARY CHANNELS, MISSISSIPPI RIVER POOL 13

BASED ON 50% ROLLUP and SEPTEMBER 2000 FAUCETT TRAFFIC FORECAST

				WITHOUT PROJECT						ALTERNATIVE B			ALTERNATIVES E, F, and J			ALTERNATIVES K and L		
				YEAR 2000 - 2,231 TOWS			YEAR 2050 - 2,483 TOWS			YEAR 2050 - 2,784 TOWS			YEAR 2050 - 3,165 TOWS			YEAR 2050 - 3,522 TOWS		
SEC Number	WATER AREA (acres)	AVG. DEPTH (ft)	ADJACENT SEDIMENT TYPE	LOAD into SEC (acre-ft/yr	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (acre-ft/yr	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (acre-ft/yr	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (acre-ft/yr	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (acre-ft/yr	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
SEC1	124	5.3	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC2	69	5.4	cohesive-med	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00000	BLUE	0.0000	0.00001	BLUE
SEC3	4	1.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC4	20	6.3	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC5	39	2.9	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC6	28	4.0	cohesive-med	0.0000	0.00003	BLUE	0.0000	0.00003	BLUE	0.0000	0.00003	BLUE	0.0000	0.00000	BLUE	0.0000	0.00003	BLUE
SEC7	333	6.1	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC8	79	8.5	cohesive-soft	0.2929	0.11300	YELLOW	0.3257	0.12566	YELLOW	0.3654	0.14097	YELLOW	0.0000	0.00000	YELLOW	0.3742	0.14438	YELLOW
SEC9	39	2.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC10	48	6.5	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC11	44	3.8	cohesive-med	0.0008	0.00053	BLUE	0.0008	0.00059	BLUE	0.0010	0.00066	BLUE	0.0000	0.00000	BLUE	0.0010	0.00068	BLUE
SEC12	28	2.9	cohesive-med	0.2239	0.24372	YELLOW	0.2490	0.27108	YELLOW	0.2793	0.30407	YELLOW	0.0000	0.00000	YELLOW	0.2861	0.31144	YELLOW

Note: To convert acres to square meters, multiply by 4,046.873; to convert feet to meters, multiply by 0.3048; to convert acre-ft/year to cu m/year, multiply by 1,233.49.

(year 2000, without project) to a high of 0.31 cm/year (year 2050, Alternatives K and L). It should be noted that in the Pool 13 backwaters the Faucett traffic produced lower values, when compared to the original scenarios, for all conditions except for the without-project scenario in the year 2000 and about the same for the Alternative B scenario in the year 2050. This trend was because the Faucett scenario had higher traffic levels in the year 2050 for the without-project, about the same for the Alternative B conditions, and slightly lower projected traffic for all of the other conditions (compare Table C5 and Table 7). That trend was maintained for the Pool 13 secondary channels also (compare Table C6 and Table 8).

Pool 26. The last Mississippi River trend pool considered for the recomputation and analysis was Pool 26. The results of the computations using the Faucett traffic projections for sediment delivered to Pool 26 backwaters are presented in Table C7 and to Pool 26 secondary channels in Table C8. Pool 26 was divided into two sections at the confluence of the Mississippi River and the Illinois Waterway. This separation was necessary since the towboat traffic level on the Mississippi River downstream of the confluence is significantly greater than upstream of the confluence. Computations indicated that when the Faucett traffic forecast was used, all backwaters were considered to have negligible impacts and were colored BLUE for without-project and all alternatives. All of the secondary channels in Pool 26 had negligible sediment delivered with the Faucett traffic scenarios and have impact color BLUE. Three secondary channels (SEC6, SEC7, and SEC8) were not included in the computations since their inlets are on the Mississippi River and their outlets on the Illinois Waterway. Since for all years and all conditions and alternatives the Faucett traffic projections were less than the original projections, it could be anticipated that lower impacts would be computed with the Faucett traffic. Upstream of the confluence the Faucett projections reduced traffic levels (compared to the original traffic projections) from zero to about 6 percent, while downstream of the confluence traffic levels decreased from about 6 to 10 percent. For the Pool 26 backwaters, Table C7 and Table 9 can be compared to see the projected impacts in this traffic reduction trend. Table C8 and Table 10 can be compared to see the reduced projected impacts on Pool 26 secondary channels.

Analysis and extrapolation based on trend pool sedimentation

The computations conducted using the Faucett traffic scenarios in the Mississippi River trend pools produced relatively minor changes in the sedimentation into backwaters and secondary channels compared with the original traffic projections. In Pools 4 and 8 the Faucett traffic for all alternatives and the without-project condition in the year 2050 increased projected traffic by 1 to about 8 percent. These are rather insignificant increases when one considers the uncertainty of computations to actually determine the sediment volumes entering inlets to backwaters and secondary channels. In Pool 13 the Faucett traffic projections varied from about a 1 percent increase to 4 percent decrease in traffic for all conditions. In Pool 26 the Faucett traffic was zero to 6 percent lower than the original traffic projections for all conditions upstream of the confluence of the Mississippi River and Illinois Waterway, and downstream of the confluence the Faucett traffic was 6 to 10 percent less than the original traffic. Therefore,

TABLE C7. SEDIMENTS TO BACKWATERS, MISSISSIPPI RIVER POOL 26

BASED ON 50% ROLLUP and SEPTEMBER 2000 FAUCETT TRAFFIC FORECAST

			WITHOUT PROJECT						ALTERNATIVE B		
(UPSTREAM of IWW)			YEAR 2000 - 3,577 TOWS			YEAR 2050 - 4,064 TOWS			YEAR 2050 - 4,589 TOWS		
(DOWNSTREAM of IWW)			YEAR 2000 - 7,876 TOWS			YEAR 2050 - 10,467 TOWS			YEAR 2050 - 11,039 TOWS		
BW Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
POOL 26 UPSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY											
BW1	379	cohesive-med	0.0000	0.00062	BLUE	0.0000	0.00071	BLUE	0.0000	0.00080	BLUE
BW1			0.0077			0.0088			0.0099		
BW2	157	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW2			0.0000			0.0000			0.0000		
BW6	690	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW6			0.0000			0.0000			0.0000		
BW7	33	cohesive-med	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE
POOL 26 DOWNSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY											
BW8	100	cohesive-med	0.0012	0.00037	BLUE	0.0016	0.00049	BLUE	0.0017	0.00051	BLUE
BW9	73	cohesive-med	0.0021	0.00090	BLUE	0.0029	0.00119	BLUE	0.0030	0.00126	BLUE
BW10	85	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW11	340	cohesive-med	0.0211	0.00189	BLUE	0.0281	0.00252	BLUE	0.0296	0.00265	BLUE
BW12	227	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE

			ALTERNATIVE E			ALTERNATIVES F and J			ALTERNATIVES K and L		
(UPSTREAM of IWW)			YEAR 2050 - 5,326 TOWS			YEAR 2050 - 5,334 TOWS			YEAR 2050 - 5,707 TOWS		
(DOWNSTREAM of IWW)			YEAR 2050 - 11,850 TOWS			YEAR 2050 - 12,045 TOWS			YEAR 2050 - 12,466 TOWS		
BW Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into BW (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
POOL 26 UPSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY											
BW1	379	cohesive-med	0.0000	0.00093	BLUE	0.0000	0.00093	BLUE	0.0000	0.00099	BLUE
BW1			0.0115			0.0115			0.0123		
BW2	157	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW2			0.0000			0.0000			0.0000		
BW6	690	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW6			0.0000			0.0000			0.0000		
BW7	33	cohesive-med	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE
POOL 26 DOWNSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY											
BW8	100	cohesive-med	0.0018	0.00055	BLUE	0.0018	0.00056	BLUE	0.0019	0.00058	BLUE
BW9	73	cohesive-med	0.0032	0.00135	BLUE	0.0033	0.00137	BLUE	0.0034	0.00142	BLUE
BW10	85	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
BW11	340	cohesive-med	0.0318	0.00285	BLUE	0.0323	0.00289	BLUE	0.0334	0.00300	BLUE
BW12	227	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE

Note: To convert acres to square meters, multiply by 4,046.873; to convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] BW3, BW4, and BW5 not included since they are on Illinois Waterway.

TABLE C8. SEDIMENTS TO SECONDARY CHANNELS, MISSISSIPPI RIVER POOL 26												
BASED ON 50% ROLLUP and SEPTEMBER 2000 FAUCETT TRAFFIC FORECAST												
				WITHOUT PROJECT						ALTERNATIVE B		
(UPSTREAM of IWW)				YEAR 2000 - 3,577 TOWS			YEAR 2050 - 4,064 TOWS			YEAR 2050 - 4,589 TOWS		
(DOWNSTREAM of IWW)				YEAR 2000 - 7,876 TOWS			YEAR 2050 - 10,467 TOWS			YEAR 2050 - 11,039 TOWS		
SEC Number[1]	WATER AREA (acres)	AVG. DEPTH (ft)	ADJACENT SEDIMENT TYPE	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
POOL 26 UPSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY												
SEC1	51	4.4	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC2	408	4.6	noncohesive	0.0010	0.00007	BLUE	0.0011	0.00008	BLUE	0.0012	0.00009	BLUE
SEC3	56	4.5	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC4	25	7.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC5	588	12.3	noncohesive	0.0002	0.00001	BLUE	0.0002	0.00001	BLUE	0.0003	0.00001	BLUE
SEC5				0.0000			0.0000			0.0000		
SEC5				0.0000			0.0000			0.0000		
POOL 26 DOWNSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY												
SEC9	81	12.4	cohesive-med	0.0001	0.00003	BLUE	0.0001	0.00004	BLUE	0.0001	0.00004	BLUE
SEC10	243	15.6	cohesive-med	0.0015	0.00019	BLUE	0.0020	0.00026	BLUE	0.0022	0.00027	BLUE
SEC11	586	9.2	cohesive-med	0.0063	0.00033	BLUE	0.0083	0.00043	BLUE	0.0088	0.00046	BLUE
				ALTERNATIVE E			ALTERNATIVES F and J			ALTERNATIVES K and L		
(UPSTREAM of IWW)				YEAR 2050 - 5,326 TOWS			YEAR 2050 - 5,334 TOWS			YEAR 2050 - 5,707 TOWS		
(DOWNSTREAM of IWW)				YEAR 2050 - 11,850 TOWS			YEAR 2050 - 12,045 TOWS			YEAR 2050 - 12,466 TOWS		
SEC Number[1]	WATER AREA (acres)	AVG. DEPTH (ft)	ADJACENT SEDIMENT TYPE	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	LOAD into SEC (AF/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
POOL 26 UPSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY												
SEC1	51	4.4	cohesive-med	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC2	408	4.6	noncohesive	0.0014	0.00011	BLUE	0.0014	0.00011	BLUE	0.0015	0.00011	BLUE
SEC3	56	4.5	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC4	25	7.4	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC5	588	12.3	noncohesive	0.0003	0.00002	BLUE	0.0003	0.00002	BLUE	0.0003	0.00002	BLUE
SEC5				0.0000			0.0000			0.0000		
SEC5				0.0000			0.0000			0.0000		
POOL 26 DOWNSTREAM OF CONFLUENCE WITH ILLINOIS WATERWAY												
SEC9	81	12.4	cohesive-med	0.0001	0.00004	BLUE	0.0001	0.00005	BLUE	0.0001	0.00005	BLUE
SEC10	243	15.6	cohesive-med	0.0015	0.00019	BLUE	0.0024	0.00030	BLUE	0.0024	0.00031	BLUE
SEC11	586	9.2	cohesive-med	0.0094	0.00049	BLUE	0.0096	0.00050	BLUE	0.0099	0.00052	BLUE

Note: To convert acres to square meters, multiply by 4,046.873; to convert feet to meters, multiply by 0.3048; to convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] SEC6, SEC7, and SEC8 not included since they cross over into the Illinois Waterway.

in Pools 13 and 26 the change in projected traffic using the Faucett scenario versus the original traffic projections produced insignificant differences in sedimentation to backwaters and secondary channels.

This study used the most complete data sets available as input to the various physical and numerical modeling tools available or developed to accomplish a systemwide analysis of the Mississippi River and Illinois Waterway. The analysis and extrapolation methods developed and presented earlier in this report are still valid and applicable to the sedimentation projections computed based on the Faucett traffic projections.

Results in Mississippi River nontrend Pools 1 through 25

As stated previously, the computation of sedimentation into backwater and secondary channel inlets using the Faucett traffic projections produced very small differences from what was computed using the original traffic projections. Therefore, after taking all of the issues into consideration, it was determined that sedimentation into backwaters and secondary channels as a result of the traffic projected for all conditions by Faucett would not produce any greater or less impact than was projected from the original traffic. Therefore, all backwaters and secondary channels predicted to have a medium potential for impacts from towboat navigation with the original traffic scenarios and alternatives have been determined to have medium impact potential with the Faucett traffic scenarios.

The backwaters and secondary channels impacted with the Faucett traffic scenarios are presented in Table 22 for the trend and nontrend pools. The backwaters having the potential for medium impacts and designated YELLOW are BW8 and BW10 in Pool 2, BW2 in Pool 3, BW2 and BW4 in Pool 5, BW1 in Pool 6, BW2 in Pool 8, BW4 in Pool 9, BW10 in Pool 10, BW1 and BW3 in Pool 11, and BW11 in Pool 13. The secondary channels with the potential for medium impacts and designated YELLOW are SEC1 in Pool 3, SEC8 in Pool 8, SEC3 in Pool 9, and SEC8 (for Alternatives K and L only) and SEC12 in Pool 13.

Illinois Waterway

Results in LaGrange Pool

The LaGrange Pool is the only trend pool on the Illinois Waterway. Table C9 presents the results of the computations for sediment delivered to backwaters and secondary channels on the LaGrange Pool of the Illinois Waterway using the Faucett traffic scenarios. For the year 2000, without project, BW2 and BW5 were given a BLUE designation since the sediment load and rate of sediment delivered to the backwaters were slightly less than the level of significance. However, for all of the Faucett traffic scenarios in the year 2050 BW2 had rates of sediment delivered of about 0.14 cm/year. For the same scenarios in the year 2050 BW5 sediment load varied from 1.40 to 1.46 acre-ft/year (1,726.89 to 1,800.89 cu m/year). As presented in Table C9, BW6 has a high potential for impacts and was given an impact color of RED based on the

TABLE C9. SEDIMENTS TO BACKWATERS AND SECONDARY CHANNELS, ILLINOIS WATERWAY, LAGRANGE POOL

BASED ON 50% ROLLUP and SEPTEMBER 2000 FAUCETT TRAFFIC FORECAST

			WITHOUT PROJECT						ALTERNATIVE F			ALTERNATIVES J & K		
						ALTERNATIVES B, E, & L								
			YEAR 2000 - 3,547 TOWS			YEAR 2050 - 5,313 TOWS			YEAR 2050 - 5,446 TOWS			YEAR 2050 - 5,517 TOWS		
BW or SEC Number[1]	WATER AREA (acres)	ADJACENT SEDIMENT TYPE	SEDIMENT LOAD (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	SEDIMENT LOAD (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	SEDIMENT LOAD (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR	SEDIMENT LOAD (acre-ft/yr)	SEDIMENT DELIVERED (cm/yr)	IMPACT COLOR
BW1	3437	cohesive-med	0.0002	0.00000	BLUE	0.0002	0.00000	BLUE	0.0002	0.00000	BLUE	0.0003	0.00000	BLUE
BW2	171	noncohesive	0.5157	0.09192	BLUE	0.7723	0.13765	YELLOW	0.7917	0.14111	YELLOW	0.8020	0.14295	YELLOW
BW3	398	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0001	0.00000	BLUE
BW4	2080	cohesive-med	0.7090	0.01039	BLUE	1.0625	0.01557	YELLOW	1.0888	0.01596	YELLOW	1.1031	0.01616	YELLOW
BW5	993	cohesive-med	0.4825	0.04717	BLUE	0.7231	0.07068	YELLOW	0.7410	0.07243	YELLOW	0.7506	0.07338	YELLOW
BW5		cohesive-med	0.9372			1.4044			1.4391			1.4579		
BW5		cohesive-med	0.1170			0.1753			0.1796			0.1820		
BW6	15	cohesive-med	0.6351	1.60748	RED	0.9515	1.93354	RED	0.9752	1.98167	RED	0.9880	2.00771	RED
BW8	179	cohesive-med	0.1560	0.02657	BLUE	0.2337	0.03979	BLUE	0.2395	0.04079	BLUE	0.2427	0.04132	BLUE
SEC1	7	cohesive-med	17.9649	78.2242	RED	26.8967	117.1159	RED	27.5735	120.0628	RED	27.9314	121.62117	RED
SEC2	21	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE	0.0000	0.00000	BLUE
SEC3	10	cohesive-med	0.0421	0.12819	YELLOW	0.0630	0.19210	YELLOW	0.0646	0.19691	YELLOW	0.0655	0.19953	YELLOW
SEC5	6	noncohesive	0.0000	0.00000	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE	0.0000	0.00001	BLUE
SEC6	69	noncohesive	0.6836	0.30198	YELLOW	1.0247	0.45265	YELLOW	1.0500	0.46381	YELLOW	1.0637	0.46990	YELLOW
SEC7	24	noncohesive	0.0021	0.00271	BLUE	0.0032	0.00407	BLUE	0.0033	0.00416	BLUE	0.0033	0.00422	BLUE
SEC8	16	cohesive-med	0.0014	0.00276	BLUE	0.0022	0.00413	BLUE	0.0022	0.00423	BLUE	0.0022	0.00428	BLUE

Note: To convert acres to square meters, multiply by 4,046.873. To convert acre-ft/year to cu m/year, multiply by 1,233.49.

[1] BW7 not included because tributary flows through it. SEC4 not included due to insufficient data

sediment delivery rate exceeding 1 cm/year for all conditions. The sediment delivered into that backwater varies from 1.61 cm/year in the year 2000, without project, to a high of 2.01 cm/year with Alternatives J and K in the year 2050. While BW4 had low potential for impacts for without-project conditions in the year 2000, by the year 2050 for the without-project conditions and for all alternatives, this backwater had medium potential for impacts. Therefore, BW4 initially had a low potential for impacts and was colored BLUE, but subsequently changed to medium potential and colored YELLOW. This was based on the sediment load exceeding the 1.0 acre-ft/year (1,233.5 cu m/year) level of significance.

The results of computations of the LaGrange Pool secondary channels using the Faucett traffic projections are also presented in Table C9. The results indicated that SEC1 had significant potential for impacts with the sediment loads and sediment rates delivered having very high values for all conditions. Therefore, SEC1 was designated RED. SEC3 and SEC6 had the potential for medium impacts. For SEC3 the sediment rate delivered varied from 0.13 cm/year for the year 2000 without project to a high of 0.20 cm/year for Alternatives F, J and K in year 2050. SEC6 varied from 0.30 to 0.47 cm/year for the same traffic scenarios. Therefore, SEC3 and SEC6 were given the medium impact potential color YELLOW.

Analysis and extrapolation based on LaGrange Pool sedimentation

As was the case on the Mississippi River using the Faucett traffic scenarios, computations conducted on the LaGrange Pool of the Illinois Waterway produced relatively minor changes in the sedimentation into backwaters and secondary channels compared with the original traffic projections. A review of Table C1 shows that in the LaGrange Pool with the Faucett traffic projections for without-project and all alternatives, projected traffic decreased by about 6 to about 10 percent. These are rather insignificant decreases when one considers the uncertainty of computations to actually determine the sediment volumes entering inlets to backwaters and secondary channels.

However, it should be noted that when the results from the original and Faucett traffic projections are compared, there are some differences. Comparison of Table C9 and Table 15 shows that for the without-project conditions in the year 2000, BW2 and BW5 had a medium potential for impact with the original traffic (Table 15) and negligible potential for impact with the Faucett traffic (Table C9). Nevertheless, those two backwaters were eventually impacted and in fact were not that much below the levels of significance with the Faucett traffic in the year 2000.

This study used the most complete data sets available as input to the various physical and numerical modeling tools available or developed to accomplish a systemwide analysis of the Mississippi River and Illinois Waterway. The analysis and extrapolation methods developed and presented earlier in this report are still valid and applicable to the sedimentation projections computed based on the Faucett traffic projections.

Results in Illinois Waterway nontrend pools

As was the case on the Mississippi River pools, the computation of sedimentation into Illinois Waterway backwater and secondary channel inlets using the Faucett traffic projections produced very small differences from what was computed using the original traffic projections. Therefore, after taking all of the issues into consideration, it was determined that sedimentation into backwaters and secondary channels as a result of the traffic projected for all conditions by Faucett projection would not produce any significantly greater or less impact than was projected from the original traffic. Therefore, all backwaters and secondary channels predicted to have a medium or high potential for impacts from towboat navigation with the original traffic scenarios and alternatives have been determined to have the same impact potential with the Faucett traffic scenarios.

The backwaters and secondary channels impacted with the Faucett traffic scenarios are presented in Table 22 for the trend and nontrend pools. The backwaters with the potential for medium impacts and designated YELLOW are BW2 in Dresden Island Pool; BW10 in Peoria Pool; BW2, BW4, and BW5 in the LaGrange Pool 2; and BW2 in the Alton Pool 3. BW6 in the LaGrange Pool was determined to have a high potential for impact and was colored RED. The secondary channels with the potential for medium impacts and designated YELLOW were SEC1 and SEC-A in the Marseilles Pool; SEC1 and SEC2 in the Starved Rock Pool; SEC2, SEC-A, SEC-B, and SEC-C in the Peoria Pool; SEC3 and SEC6 in the LaGrange Pool; and SEC-B, SEC-D, SEC-E, and SEC-F in the Alton Pool. SEC1 in the LaGrange Pool was determined to have a high potential for impact and was designated RED.

Mississippi River Open-River Portion

The results of computations conducted for the open-river portion of the Mississippi River resulted in no backwaters or secondary channels being impacted for any of the conditions considered (Tables 19 and 20). Table C10 shows the traffic for the original and Faucett projections. For all conditions the Faucett traffic is between 3 and 5 percent less than the original projected traffic. Therefore, it was concluded that since no backwaters or secondary channels were impacted with the original projected traffic, the lower Faucett traffic would not change those previous results. Thus all backwaters and secondary channels in the open-river portion of the Mississippi River would have negligible impacts from towboat navigation based on the Faucett traffic projection and were given an impact color of BLUE.

Summary and Conclusions

The Faucett traffic projections were slightly higher (7 percent or less) in Mississippi River Pools 4 and 8 than the original traffic projections for all conditions for the year 2050. In Pool 13 for without-pool and Alternative B conditions in year 2050 the Faucett traffic was 1 percent or less than the original

Table C10
Original and September 2000 Faucett Traffic Scenarios for Open-River Reach, Mississippi River

Plan	Year	Original Projected Traffic (Tows/Year)	September 2000 Faucett Projected Traffic (Tows/Year)
Without Project	2000	8,989	8,630
Without Project	2050	12,293	11,935
Alternative B	2050	12,563	12,159
Alternative E	2050	12,946	12,475
Alternative F	2050	13,100	12,540
Alternative J	2050	13,167	12,576
Alternative K	2050	13,320	12,745
Alternative L	2050	13,088	12,645

projections. For all other cases in the Mississippi River pools, the LaGrange Pool, and the open-river reach, the Faucett traffic was zero to 10 percent less than the original traffic projections.

Based on the results on the Mississippi River Pools 1 through 26, the backwaters and secondary channels determined to have the potential for impacts with the original traffic were also determined to have similar impacts with the Faucett traffic projections. The same situation was also true for the Illinois Waterway and the open-river reach of the Mississippi River. Table 21 presents a summary of the backwaters and secondary channels impacted on the Mississippi River and Illinois Waterway. Table 22 presents the specific Mississippi River and Illinois Waterway backwaters and secondary channels determined to be potentially impacted by towboat navigation.

In reviewing the results of this study it should be taken into account that only the sediment volumes delivered to inlets of backwaters and secondary channels were computed. Also, the volumes and rates of filling computed were the result of only bed material resuspended by towboats. Sediment delivered due to ambient flow, wind, recreational vessels, or flood events are not included in this analysis. Additionally, the fact that median, rather than mean, sediment values were used in determining potential impacts may have an influence on the volume of sediment entering backwaters and secondary channels. Therefore, the areas designated as YELLOW or RED should be considered merely as having the potential for impacts from towboats. These areas should be reviewed and analyzed geomorphically to determine what has occurred in those areas in the past. This will give a reasonable evaluation of the overall performance of a backwater or secondary channel to carry the input sediments through the area and back to the main river channel.

Conversely, sediments introduced into backwaters have the potential for longer retention in those areas. Once the sediments pass through the inlet channels and get into lower velocity areas, they could deposit in that area and form somewhat of a delta where the inlet channel meets the backwater. More than likely, if the sediments do settle out and deposit, they will remain there for an undetermined period of time. It is possible that yearly-normal or above-normal flow events (floods) will resuspend the sediments and move them down the system. There is also the potential for wind waves, recreational vessels, or their waves to resuspend the sediments. However, this study effort does not address the ultimate fate of those deposits.

The backwaters and secondary channels designated as having YELLOW or RED impact potentials could be considered for mitigation if it is determined that geomorphically those areas have been conducive to deposition in the past. In areas where the sediment input potential is due to the close proximity of the inlet to the navigation channel, perhaps the navigation channel can be moved river-ward and away from the inlet. In areas where the potential is high due to relatively large discharges into backwaters or secondary channels, perhaps some type of structure could be constructed in the inlet channel to limit the volume of water, and consequently the sediment volume, entering the area.