THESIS

VARIABILITY IN TOTAL SEDIMENT LOAD USING BORAMEP ON THE RIO GRANDE LOW FLOW CONVEYANCE CHANNEL

Submitted by

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Civil Engineering

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Spring 2006

COLORADO STATE UNIVERSITY

FEBRUARY 2, 2006

WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY SEEMA C. SHAH ENTITLED VARIABILITY IN TOTAL SEDIMENT LOAD USING BORAMEP ON THE RIO GRANDE LOW FLOW CONVEYANCE CHANNEL BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

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ABSTRACT OF THESIS

VARIABILITY IN TOTAL SEDIMENT LOAD USING BORAMEP ON THE RIO GRANDE LOW FLOW CONVEYANCE CHANNEL

The Bureau of Reclamation Automated Modified Einstein Procedure (BORAMEP) is a computer program developed by the US Bureau of Reclamation to estimate total sediment load in open sand bed channels. In previous studies using BORAMEP, the program produced obvious calculation errors and error message. In one case, the program was used to estimate the total sediment and suspended sediment loads within the Low Flow Conveyance Channel (LFCC). On average the total sediment load calculated using BORAMEP was lower then the measured load at the sampling sills.

This thesis documents work utilizing measured data from the LFCC in a series of BORAMEP calculation to check the program and identify possible improvements. In the detailed analysis, input data were purposefully varied to evaluate the effect on total sediment load calculated using BORAMEP. The LFCC data includes three measured cross sections sampled on three occasions at 300 cfs and 600 cfs. Section LF-11 at 300 cfs was identified as the most suitable cross section and three vertical profiles were selected for further BORAMEP application. In calculations using the baseline conditions, the overlap between the measured suspended sediment and bed load were varied from 0 to 5%. Minimal errors were found when the overlap ranged from 1 to 2%, and an overlap of 1.3% was chosen for additional analysis. The total load calculated at each vertical profile varied by less than 8 tons per day, which is less than 9% variability.

Variability analyses of BORAMEP parameters were performed. The following parameters and combinations were varied to develop fifteen case studies: flow depth, top width, discharge, velocity, concentration, vertical sampling depth, d_{35}, d_{65}, and water temperature. Summary of results suggested inconsistencies in error message and total load calculations. When flow depth, top width, discharge or mean flow velocity were modified BORAMEP would calculate total load, even though continuity was violated and flow depth did not equal measured plus unmeasured depth. Occasionally, the program calculated total sediment load when d_{35} was greater than d_{65} and when d_{35} and d_{65} were outside the measured particle distribution, which is physically impossible. As the input for water temperature fell below freezing (32ºF), the program did not account for the effects of ice; and occasionally, calculated total load when it should have provided an error. In addition, the program could not calculate total load when concentration, flow depth, top width, discharge or velocity were set equal to zero. In all these cases the total load should have been calculated as zero. Finally there is no criterion for incipient motion within the program. Reasonable results were obtained when continuity was satisfied. In many scenarios, error messages occurred and the program terminated not clearly providing an explanation to the actual problem that occurred during the total load calculations, making trouble shooting difficult.

A summary of suggested changes in the program are provided. This variability analysis resulted in a list of recommended input and calculation checks, and additional error messages for incorporation in the program. Ten recommended checks and seven additional error messages have been suggested.

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ACKNOWLEDGEMENTS

I would like to express my gratitude to the USBR for giving me the opportunity and funding to work on this project. In addition, I thank my advisor Dr. Pierre Julien, whom provided constant guidance, encouragement, and suggestions. He was very instrumental in keeping me on course. I also like extend my thanks to my Master program committee members: Dr Ramchand Oad of the Civil Engineering Department and Dr Ellen Wohl of the Geosciences Department.

I also extend a special thanks to my peers: Mark, Forrest, Susan, Chad, Un, Max, Leif and Mike. They all have been great friends and provided me the necessary guidance to have a successful career at CSU. I'm extending special thanks to Mark whom rode his bike with me every morning and helped me with reading programming code.

I would like to thank my family: my parents (Chandrakant and Pramila), my brother Amit and sister in-law Urvi whom all have provided continual support and encouragement throughout my studies. And finally, I would like to thank my fiancé, Tim for his unconditional love and support. I love you all.

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List of Symbols

A	channel cross-sectional area
a	limit of integration
A'	fraction of flow depth not sampled
A''	mathematical abbreviation
b	limit of integration
B_*	constant equal to 0.143
C	measured suspended sediment concentration
d_i	geometric mean for each size class
d_n'	vertical distance not sampled
d_s'	vertical distance sampled
d_s	material grain size (particle diameter)
d_{35}	effective size (particle diameter corresponding to 35% finer)
d_{65}	effective size (particle diameter corresponding to 65% finer)
EFR	Error Function
F	mathematical abbreviation
Fr	Froude number
g	acceleration due to gravity
h	flow depth
i_B	fraction of bed material in a given size range
i_s	fraction of suspended material in a given size range
I_1''	mathematical abbreviation that contains J1" and A"
I_2''	mathematical abbreviation
J_1'	mathematical abbreviation that contains A'
J_1''	mathematical abbreviation that contains A"
J_2'	mathematical abbreviation that contains A'
k_s	effective roughness
P	MEP transport parameter
p	Probability that a particle will be entrained in the discharge
Q	flow discharge
Q_{Bi}	bed load for each size fraction
q_B	unit bed load for a given size fraction
Q_s	Measured suspended load
Q'_s	suspended load
$Q'_{s\ total}$	total sampled suspended load
$Qs_{total\ suspended}$	total sediment load due to suspended sediment (measured + unmeasured)
$Qs_{total\ bed}$	total sediment load due to bed-load (measured + unmeasured)
Qs_{total}	total sediment load
R	hydraulic radius (A / WP)
S_f	friction slope
T	temperature
t	time

U_*	shear velocity
V	flow velocity
V_{avg}	average stream velocity
W	active channel width
WP	wetted perimeter
X	dimensionless parameter
Z	theoretical exponent for vertical distribution of sediment
δ	laminar sublayer thickness
ν	kinematic viscosity
φ	intensity of bed-load transport
γ	specific weight of water
γ_s	specific weight of sediment
η_0	constant equal to 0.5
ω	fall velocity
ψ	shear intensity for all particle sizes

List of Acronyms

agg/deg	Middle Rio Grande aggradation and degradation lines
BORAMEP	Bureau of Reclamation Automated Einstein Procedure
cfs	cubic-feet-per-second (ft^3/s)
Compact	Rio Grande Compact
ft	feet
ft/sec	feet per second
LF-11	Low Flow at cross section 11
LF-25	Low Flow at cross section 25
LF-39	Low Flow at cross section 39
LF-FB	Low Flow at Foot Bridge
LF-VB	Low Flow at Vehicle Bridge
LFCC	Low Flow Conveyance Channel
MEP	Modified Einstein Procedure
mg/l	milligrams per liter
mm	millimeter
MRG	Middle Rio Grande
MRGCD	Middle Rio Grande Conservancy District
ppm	parts per million
SS	Suspended Sediment
TL	Total Load
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation

Chapter 1: Introduction

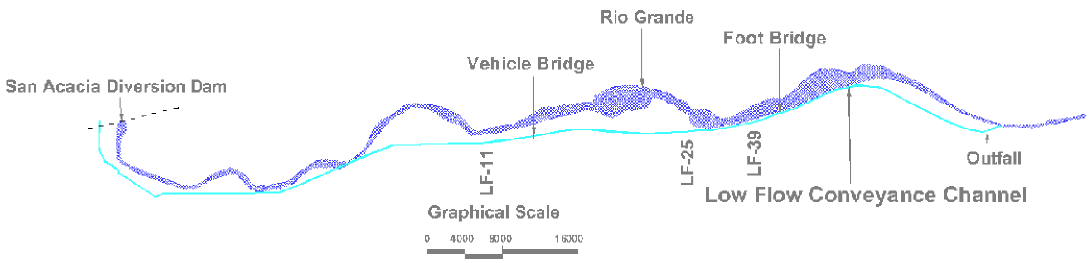
1.1 Overview

The Middle Rio Grande (MRG) stretches 143 miles through central New Mexico. This reach of river begins in White Rock Canyon and extends downstream through the San Marcel Constriction at Elephant Butte Reservoir. The river flows from rugged mountainous terrain into the flat broad plain of arid New Mexico. As a result of urbanization and deforestation within the watershed, sediment loads within the river have increased dramatically. These sediments have deposited on the channel bed causing the width to increase and flow velocities to decrease. Sediment deposition has caused aggradation of both the river bed and the surrounding floodplain. This channel instability has caused bank erosion and lateral channel migration (Richard 2001). Flooding has occurred frequently and many acres of agricultural land have been destroyed.

In 1925 the Middle Rio Grande Conservancy District (MRGCD) was established to address flooding and the deterioration of irrigation channels. However, during the Great Depression of the 1930s the MRGCD was unable to raise the funds needed to maintain irrigation and drainage facilities. The Congressional Flood Control Acts of 1948 and 1950 provided necessary federal aid to the district. With that funding, many facilities were rehabilitated and modernized and extensive portions of the Rio Grande were channelized. Numerous major flood control and flow regulation structures were constructed along the river including levees, reservoirs, and dams. Improvements were also made to irrigation canals to improve water delivery to local agricultural lands. Finally, a low flow conveyance channel was constructed to improve water delivery.

The Low Flow Conveyance Channel (LFCC) was constructed from San Acacia Dam to Elephant Butte Reservoir (Figure 1.1). The purpose of the LFCC is to reduce travel time and water losses associated with riparian zones in an efficient channel. Thus, the LFCC has increased water delivery to Elephant Butte Reservior. Construction on the LFCC began in 1951 and was completed in 1959. The channel extends 58 miles along the west bank of the river. Flows are diverted into the LFCC at the San Acacia Diversion Dam. The LFCC was necessary because water levels within Elephant Butte Reservoir had fallen well below the level necessary to provide water to the lower portion of the river as required by the Rio Grande Compact of 1938. The flow reduction to Elephant Butte Reservoir is attributed to upstream diversions, transmission loss (infiltration) and evaporation. The LFCC is maintained by the United States Bureau of Reclamation (USBR) and has a 32 foot bottom width, 2:1 side slopes, and a design conveyance capacity of 2,000 cfs. From the late 1950s through the early 1980s, river flows were diverted to the LFCC, improving water delivery to the reservoir. However, in 1985 diversions to the LFCC were stopped due to channel sedimentation and reservoir limitation.

To better manage water delivery efforts the USBR needs to quantify sediment transport through the LFCC by maintaining the required water levels in Elephant Butte Reservoir. However, developing a reliable procedure for collecting and calculating total sediment is difficult (Burkham and Dawdy, 1980). Using graphs, empirical equations and engineering judgment can result in widely different answers. The Bureau of Reclamation Automated Modified Einstein Procedure (BORAMEP) was developed to improve the consistency of sediment transport estimates. Holmquist-Johnson and Raff at the USBR created this computer program to automate the total sediment load estimation process using the Modified Einstein Procedure (MEP). This thesis focuses on testing the variability of BORAMEP parameters but does not alter the existing code.



a) Schematic of LFCC along the Middle Rio Grande

b) San Acacia Diversion Dam

c) Narrows of Elephant Butte Reservoir

Figure 1.1 – Low Flow Conveyance Channel

1.2 Objectives

The objectives of this thesis are:

1. Using data from the Low Flow Conveyance Channel (LFCC), determine the optimal cross section, vertical profile and percent overlap used in calculating the total load with BORAMEP.
2. Perform a sensitivity analysis of various parameters used to calculate the variability of total load in BORAMEP. These parameters include: depth, width, discharge, concentration, vertical sampling depth, d_{35}, d_{65}, and water temperature.
3. Develop additional error messages and constraints to improve the existing BORAMEP program.

1.3 Approach and Methodology

In 2001 the USBR collected data on the LFCC at three distinct cross sections (LF-11, LF-25 and LF-39) and two sampling sills (LF-FB and LF-VB). Using these data the reliability and accuracy of BORAMEP can be determined. Jay (2005) compared the calculated total load using BORAMEP at each cross section to the measured total load at the two sampling sills for 300 and 600 cfs. His analysis revealed unexplainable error messages and a calculated total load less than the measured total load. Therefore, a sensitivity analysis was requested to determine the variability of BORAMEP.

A detailed analysis was performed on all available data to determine the most suitable cross section. Then a matrix was developed to identify the best vertical profiles and optimal percent overlap where BORAMEP worked consistently.

BORAMEP requires the input of various parameters to calculate a total sediment load. Based on the available information, fifteen permutations were developed by varying the following parameters and combinations: flow depth, top width, discharge, mean flow velocity, concentration, vertical sampling depth, d_{35}, d_{65}, and water temperature. This aided in the determination of the variability of total load calculated by the computer program.

Finally, based on the variability of total load, discrepancies were identified within BORAMEP. Lists of potential error codes are suggested to improve the program's usability. In addition, checks are suggested to insure that the program will calculate total sediment load appropriately.

This thesis is organized in five chapters. An introduction is presented in Chapter one. Chapter two is a review of literature on the Rio Grande: historical background, climate, and total sediment load procedure. A detailed explanation of BORAMEP is presented to develop a better understanding of how total sediment load is calculated. Chapter three summarizes Jay's total sediment load analysis on the LFCC using

BORAMEP. Chapter four discusses the analysis of the variability of BORAMEP has on total load calculations when the input parameters are varied. Finally, Chapter five provides conclusions and recommendations on BORAMEP.

Chapter 2: Literature Review

2.1 Introduction

The Rio Grande is 1,885 miles (3,000 kilometers) long, making it the second longest river in North America. The headwaters of the Rio Grande are located in the San Juan Mountains of southwestern Colorado and the river discharges into the Gulf of Mexico at Brownsville, Texas and Matamoras, Mexico. Prior to the settlement of the valley the river was a braided, sinuous and aggrading sand bed river (Crawford et al. 1993). Deforestation, urbanization and agricultural expansion have led to an increase in sediment loading in the Rio Grande. Due to the high sediment loading from upland and channel erosion, the river has migrated and meandered through the floodplain. Even though the river has moved, it is in a state of dynamic equilibrium, allowing for rich vegetative growth. Strahler (1957) and Hack (1960), used the term "dynamic equilibrium" to define a steady state open system, which has continuous inflow and outflow of materials and the channel form or character remains unchanged.

The MRG is a 143-mile-long river reach located in Central New Mexico from White Rock Canyon to Elephant Butte Reservoir (Figure 2.1). Over the years urbanization and agricultural expansion have increased the demands on the river. Climate changes have caused periodic flooding and morphological changes to the river. These problems have led to channel instability and flooding. Thus many dams, reservoirs, levees, diversion structures and a low flow conveyance channel were designed to address water demand and provide flood protection along the river. However, the river is still very unstable due to large fluxes of sediment.

Figure 2.1 – Middle Rio Grande River Location Map

In 1939 the Rio Grande Compact was finalized between Colorado, New Mexico and Texas. This interstate agreement was written to remove present and future controversy with respect to downstream water delivery from the Rio Grande above Fort Quitman, Texas (Anonymous, 1999). The document requires Elephant Butte Reservoir to store usable water and provide available water to downstream users. However, a series of droughts in the 1940s coupled with heavy sedimentation plugged the river and prevented flows from entering Elephant Butte Reservoir. The area upstream of the reservoir has been inundated with flood waters. The reduction of flow within the Rio Grande (Figure 2.2) threatened Elephant Butte Reservoir. In the 1950s a low flow conveyance channel (LFCC) was designed to convey flows into the reservoir from San Acacia Diversion Dam to alleviate water demands. Financial assistance for the project was provided by the federal government. Diverting water into a narrower deeper channel was more efficient because it reduced water losses associated with riparian habitat, infiltration and evaporation. The LFCC improved sediment transport and valley drainage. The LFCC was designed with a flow capacity of 2,000 cfs, a bottom width of 32 feet and 2 to 1 side slopes. This channel is maintained by the USBR. However, in 1985 major diversions into the LFCC were stopped due to channel sedimentation and reservoir capacity (Gorbach, 1999).

Figure 2.2 – Low Flows north of Highway 380 (Bosque Hydrology Group)

To better understand sediment transport, the USBR designed a computer program to calculate the total sediment load based on the Modified Einstein Procedure (MEP). BORAMEP was used to calculate total sediment load within the Middle Rio Grande (Albert, 2004). Albert's results suggested a discrepancy in the program; leading the USBR to request using data from the LFCC, to provide a better comparison between measured data and calculated total load results. Based on these results, a variability analysis was performed on BORAMEP as part of this thesis to determine the range of total load calculated, provide an explanation of error messages and provide a suggested list of detailed checks.

2.2 Historical Information on the Rio Grande River

The first people to arrive to the Rio Grande Valley came over 15,000 years ago. These nomads depended on hunting and gathering as a livelihood. As they evolved, they learned how to use the Rio Grande to provide a constant source of water via drainage ditches for irrigation. By the late 1500's the Spanish explorers arrived in New Mexico and further colonized the region. Additionally, irrigation ditches were constructed and riparian vegetation was replaced by agricultural land. Next, the Anglo Americans arrived in large numbers in the 1800's with the development of the railroad. With them came more diversions and high sediment loading within the Rio Grande and the conversion of additional floodplains into agricultural land. Currently 40 percent of the 1.8 million people of New Mexico live in the Middle Rio Grande Valley. They depend on the river for their livelihood.

The early history of the river suggested that the Rio Grande was a sinuous braided river. However, as land use changed within the watershed, downstream sedimentation increased, which caused river aggradation to accelerate. Additional sources of sediment within the watershed are attributed to urbanization, overgrazing and deforestation, which resulted in excess erosion. The channel's rapid aggradation is due to the increased sediment supply and the decreased sediment capacity within the channel.

During the 1920's, dams, levees, diversion structures and channelization works were created in efforts to protect irrigated lands from flood risks (Scurlock 1998). The state of New Mexico established the MRGCD in 1923 to improve irrigation, drainage and flood control for 128,000 acres of agricultural land (Siefert, 2001; Woodson and Martin 1962). The MRGCD's jurisdiction extended from Cochiti Dam to Bosque del Apache. A floodway was constructed in 1935 as the basic flood control element for the MRG (Woodson 1961). This floodway had an average width from levee to levee of 1,500 feet and the levees were approximately 8 feet high (Lagasse 1980). The floodway design discharge was 40,000 cfs. Additional height was extending to the levees near Albuquerque for a design discharge 75,000 cfs (Woodson and Martin 1962). However, in 1941 the levees were breached in 25 places along the river due to a major flood, which had a mean daily discharge of 22,500 cfs for a 2-month duration (Woodson and Martin 1962). These high flows over an extended period of time caused substantial flooding (Scurlock 1998). The flood inundated Albuquerque and other nearby river communities.

As a direct result of the flooding in 1941 the Army Corps of Engineers and the USBR, along with various other federal, state and local agencies, recommended the Comprehensive Plan of Improvement for the Rio Grande in New Mexico in 1948 (Pemberton 1964). As a result, sophisticated systems of reservoirs (Abiquiu, Jemez, Cochiti, and Galisteo) were constructed along the Rio Grande and its tributaries. In 1948 the Congressional Flood Control Acts passed in Congress, providing federal funds to assist with flood control projects within the country. Along the Rio Grande, government funds assisted with the development of a flood control reservoir (Cochiti Dam), levee rehabilitation, floodway clearing and jetty field installations to confine the river and provide channel stability.

2.3 Climate

The climate of the Middle Rio Grande Valley in New Mexico is defined as semi-arid. The relative humidity averages between 10 and 15% during the year. The average winter temperature is approximately 48ºF and the average summer temperature is 92ºF. The annual precipitation ranges from 10 to 12 inches. The river flows come from the upper Rio Grande watershed. With minimal rainfall in the MRGV the river is an important water source for municipal, industrial and agricultural usages.

2.4 Previous Studies

2.4.1 Rio Grande

The Middle Rio Grande Valley is highly urbanized. Several studies have been conducted regarding sediment transport and channel characteristics to better quantify the changes. These studies provide useful information on planform configuration, cross section geometry and bed material composition.

Prior to the urbanization of the MRG valley, the river was generally wide and shallow with many islands that gave it a braided pattern (Lane and Borland, 1953). In its present state the river is relatively straight with alternating narrow and wide sections. Most gauging stations are located on narrow sections of the river. Lane and Borland (1953) concluded that during high flows the bed of the Rio Grande scoured at the narrow sections and that most of the eroded material was deposited in the wide sections immediately downstream. Thus from the gaging stations one would conclude that the river was degrading, but sediment was depositing in the wider section suggesting aggradation. Nordin and Beverage had a similar finding in 1965.

The system of reservoirs that had been constructed on the Rio Grande to manage water would reduce the sediment inflow into Bernalillo by 75 percent in 20 years (Woodson and Martin, 1962). They expected that the river would degrade from Cochiti Dam to Rio Puerco by only 3 feet due to an armored layer. A similar study was conducted by the USBR with identical results. Degradation downstream was greater than expected. Post-dam observations indicated that the river bed approximately 3 miles downstream of the dam eroded one foot within the first two months of operation. Gravel bars that were not apparent before dam closure were observed along the river as far downstream from the dam as Albuquerque (Dewey et al. 1979).

Crawford and others (1993) wrote a management plan including mitigation measures to improve the riparian habitat of the Middle Rio Grande. By studying past and present conditions they were able to identify key species, communities and ecology necessary to improve habitat and recommend methods to reestablish the ecosystem.

Graf (1994) studied plutonium into the northern Rio Grande. As mentioned previously by Lane and Borland in 1953, prior to the 1940s the channel was broad and shallow with a typical configuration of a braided channel. Decreased flows transformed this braided river into a single-threaded river. This decreased flow was caused by urbanization, deforestation, over grazing and dam operation along the Rio Grande. Due to the instability of the channel, lateral migration occred of the river from one side of the valley floor to the other. From 1940s-1980s the Rio Grande has moved two thirds of a mile laterally. These changes occurred during high sediment flows, which caused the development of plugs and poorly consolidated channel banks (Graf, 1994).

2.4.2 Low Flow Conveyance Channel

At the 36th Annual New Mexico Water Conference in April of 1992, Arriaga presented *The Sedimentation Effects on Water Quality at Elephant Butte Reservoir*. In his study he determined that over 20% of the reservoir storage capacity had been lost to sedimentation from 1915 to 1988 (73 years). Sediment is being transported into the reservoir via the main channel and the low flow conveyance channel (LFCC). As the sediment deposited in the upper portion of the reservoir it is destroying riparian habitat, which plug flows from moving freely into the reservoir.

As mentioned previously, the LFCC was built in the 1950's as an efficient method of transporting flows into Elephant Butte Reservoir. In 1999, Gorbach of the USBR presented the history, significance and future of the conveyance channel. In the 1930's, as part of the Rio Grande Compact, New Mexico was required to delivered 400,000 acre feet of water downstream of Elephant Butte Reservoir; but, due to sedimentation and a period of drought, the agreement made under the Compact was violated. Flows leaving Elephant Butte Reservoir were lower than needed by downstream users. Thus the LFCC was built in the 1950's from funds provided through the Congressional Flood Control Acts. The LFCC was performing adequately until the 1980's when the lower 15 miles of the LFCC was filled with sediment. Efforts were made to move the outlet; however, sedimentation continued to be a problem. Therefore, in 1985 major flow diversions into the LFCC were suspended. Currently, the LFCC operates as a drain to collect water from irrigation return flows, shallow groundwater and water seeping from the river floodway. Due to channel aggradation there is increasing concern that the levee on the eastern bank will be breached. Hence a plan is underway to move the LFCC downstream of San Marcial and realign the river in the lower section of the floodplain near the western levee.

2.4.3 Middle Rio Grande at Colorado State University

Under the guidance of Pierre Y. Julien, many studies have been conducted along the Middle Rio Grande. The following are research studies:

- In 1998 Claudia Leon studied the morphology from Cochiti Dam to Bernalillo Bridge along the Middle Rio Grande.
- In 2000 Travis Bauer studied the morphology from Bernalillo Bridge to the San Acacia Diversion Dam along the Middle Rio Grande.
- In 2001 Gigi A. Richard looked at the lateral channel adjustments downstream of Cochiti Dam.
- In 2003 Claudia A. Leon looked at the width and instream habitat of the Rio Grande.
- In 2004 Michael J. Sixta studied the meander migration and hydraulic model of the Felipe Reach along the Middle Rio Grande.
- In 2004 Jason Albert studied the hydraulic analysis and created double mass curves from Cochiti to San Marcial.
- In 2005 Forrest Jay performed a sediment analysis on the Low Flow Conveyance Channel using BORAMEP.

In addition, detailed reach analysis have been conducted on the Middle Rio Grande to determine the effects of Cochiti Dam on the river.

- Rio Puerco Reach (Richard et al. 2001), currently being updated by Vensel (2005). This reach spans 10 miles from just downstream of the mouth of the Rio Puerco (agg/deg 1101) to the San Acacia Diversion dam (agg/deg 1206).

- Corrales Reach (Leon and Julien 2001b), updated by Albert et al. (2003). This reach spans 10.3 miles from the Corrales Flood Channel (agg/deg 351) to the Montano Bridge (agg/deg 462).
- Bernalillo Bridge Reach (Leon and Julien 2001a), updated by Sixta et al. (2003a). This reach spans 5.1 miles from New Mexico Highway 44 (agg/deg 298) to cross-section CO-33 (agg/deg 351).
- San Felipe Reach (Sixta et al. 2003b). This reach spans 6.2 miles from the mouth of the Arroyo Tonque (agg/deg 174) to the Angostura Diversion Dam (agg/deg 236).
- Cochiti Reach (Novak and Julien 2005) This reach spans 8.2 miles from Cochiti Dam (agg/deg 17) to the confluence with Galasto Creek (agg/deg 97).

Under the guidance of Ramchand Oad, irrigation studies have been conducted on the Middle Rio Grande. The following are research studies:

- In 2003 Rachel Barta studied methods to improve irrigation system performance in the Middle Rio Grande.
- In 2005, Roy Gallea studied computer decision support systems for water delivery and distribution on the Middle Rio Grande.

2.5 Total Sediment Load Procedure

Total sediment load is composed of bed and suspended load. Figure 2.3 provides a graphical representation of three distinct ways that total sediment load can be divided: measurement, movement and source. According to Einstein (1950) bed load is bed particles moving near the bed layer. The bed layer is defined as the depth of two mean grain diameters ($2d_{50}$) and suspended load is defined as particles moving outside the bed layer. Bed material load is defined as all particles that are greater than d_{10}, while all particles smaller then d_{10} are defined as washload.

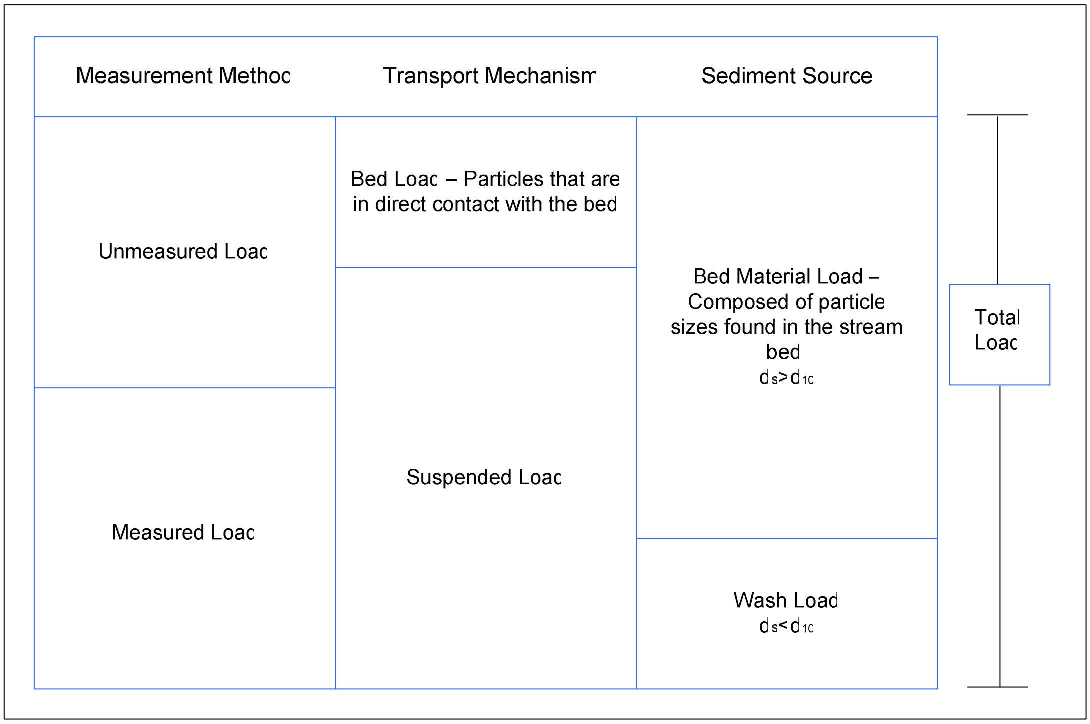


Figure 2.3 – Classification of Sediment Load (Julien, 1995)

2.5.1 Einstein Method (1950)

In 1950, Einstein developed a sediment transport model that was considered a landmark for calculating total sediment load in rivers. The method determines the bed load concentration using the bed material distribution as the starting point. Using the bed load concentration, the function is integrated to determine the suspended sediment load (Refer to Figure 2.4). Einstein total sediment load procedure is based on a uniform channel reach with an average channel cross section and energy slope (Burkham and Dawdy 1980). To use this procedure an appropriate channel length needs to be identified to determine the overall energy slope and a representative cross section is used to calculate geometric and hydraulic characteristics. Then the procedure is broken into three parts: (1) equations pertinent to suspended load, (2) equations pertinent to bed load, and (3) equations pertinent to the transition between bed load and suspended load (Burkham and Dawdy, 1980).

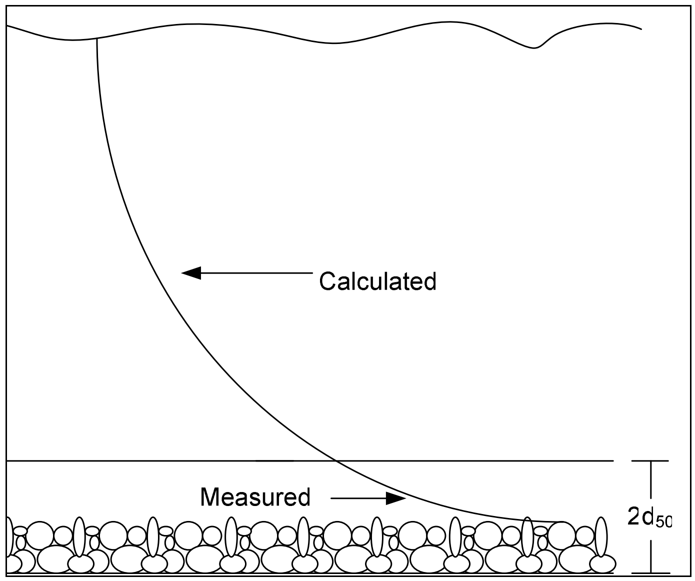


Figure 2.4 – Sediment Concentration Curve

This method requires substantial field measurements and graphs to determine the total sediment load. Not only is the procedure labor and time intensive, but the analysis produces a large percentage of error due to the numerous graphs that are used. Sediment transport rates between different analyzers can vary 20%. After the Einstein Method was developed, simpler methods have been derived that require less data. In 1955 Colby and Hembree created the Modified Einstein Procedure (MEP). This procedure is computationally simpler and uses parameters more readily available from actual stream measurements (Burkham and Dawdy, 1980).

2.5.2 Modified Einstein Method

In 1955, Colby and Hembree were working on computing total sediment discharge on the Niobrara River in Cody, Nebraska. They used different total load procedures to determine sediment discharge: Du Boys', Schoklitsch's, Straub's and Einstein's procedure. The data indicated that Einstein's Method provided the best agreement between computed sediment discharge and measured sediment discharge. However, the relative mass at the different size classes did not agree with the cross section being analyzed.

Thus a new procedure was necessary to calculate total sediment load. Colby and Hembree (1995) used the basis of the Einstein Procedure. Their total load procedure is based on computing the suspended sediment load at the cross section from the measured suspended sediment concentration. Based on the known suspended sediment load the function is integrated and the load can be calculated in the unmeasured zone. This new method is known as the Modified Einstein Procedure (MEP).

The MEP uses data collected at a single cross section. From the collected data the suspended sediment load is determined for various size fractions (size classes) based on the sampled concentration, unit discharge, unit weight of water and the ratio of measured discharge to total discharge. The bed load discharge is evaluated by calculating the shear intensity of flow acting on a given particle based on measured bed material. Various Einstein integrals are used, which are a function of Rouse number (z), the ratio of unmeasured depth to flow depth and the ratio of the bed layer thickness to the flow depth (A”). This information can then be used to determine the total load in a given channel.

According to Stevens (1985), the MEP is not applicable for design purposes because it estimates total sediment discharge for a given water discharge from the depth-integrated sediment samplers, the stream flow measurement, the bed-material sample and water temperature at a specific discharge and cross section (Simons et. al. 1992). Thus under different flow regimes the analysis results will vary. The advantage of using the MEP is that it utilizes readily available data at one cross section and computes the sediment load for all sized particles. Even though the MEP is a reliable method for calculating total sediment discharge, it uses empirical adjustments, which require engineering judgment and experience to calculate total sediment load (Burkham and Dawdy, 1980). As a result this can lead to an array of different answers. In addition, MEP involves the extrapolation of measured suspended sediment load to computed unmeasured load. It is intended to be used at sites where the bed material is less than 16 mm (sand particles) and where particle size class overlap exists between the measured suspended sediment and bed material (Stevens 1985). In 1966, Lara found that the z solved for a representative grain size did not always provide an accurate representation of the Rouse number. Thus he suggested that a trial and error approach be used that calculated z for size ranges that have significant quantities in both the bed and suspended loads. Once the z is calculated for at least two size fractions, then a relationship can be developed to determine the Rouse number for all size fractions.

Even though the MEP has similar principles to the Einstein procedure, the two methods are quite different (Simons et al. 1992). Table 2.1 compares Einstein's method to the MEP method.

Table 2.1 – Einstein Method vs. Modified Einstein Method	
Einstein Method	**Modified Einstein Method**
Based on average cross sectional data, wetted perimeter, a slope through the reach and an average particle distribution.	Field Data Measurements: stream discharge, mean velocity, cross-sectional area, width, mean depths at all suspended sediment samples, measured sediment discharge concentration, size distribution of the measured load, size distribution of bed material at a cross section, and the water temperature. No average value.
Based on uniform river reach	Based on cross section or short reach that is not necessarily uniform
Water discharge computed from formulas.	Stream Flow measurements to determine water discharge.
Estimates bed load based on bed material sample. Estimates total sediment load based on integration from bed.	Estimates total sediment discharge based on suspended sediment sample and integrates to determined sediment in unmeasured zone.
In sand bed channels	In natural rivers consisting of sand
A point sediment sampler	A depth integrated sediment sampler
Use of actual velocity	Use of average velocity
Bed samples for river reach	Suspended sediment sample from cross section
Rouse Number determined from grain shear velocity.	Rouse Number determined from shear velocity.
Used for design purposes	
Only for particles larger than and equal to 0.125 mm.	
Water Surface Slope	
	Einstein's intensity of bed load transport is arbitrarily divided by 2 to fit the observed river data.

2.5.3 Bureau of Reclamation Automated Modified Einstein Method

The USBR had developed a computer program to calculate total sediment load. BORAMEP (Bureau of Reclamation Automated Modified Einstein Method) is an automated version of a revised MEP. BORAMEP was first developed by Holmquist-Johnson in Visual Basic Application and later revised by Raff in Visual Basic. The program allows the user to enter the collected data and calculate the total sediment load.

Below is a step by step procedure for calculating the total sediment load at a given section. The first step is to calculate suspended sediment load by size fraction based on the measured sediment concentration.

1. Calculated suspended sediment in tons per day

$$Q_s = Q * C \qquad \text{(Eq 2.1)}$$

Where:

Q_s = suspended sediment load (tons/day);

Q = discharge (cfs);

C = suspended sediment concentration (mg/l).

2. Figure 2.4 is based on Einstein's Plate #3. An equation was developed to relate the relative roughness (x) to the ratio of k_s/δ.

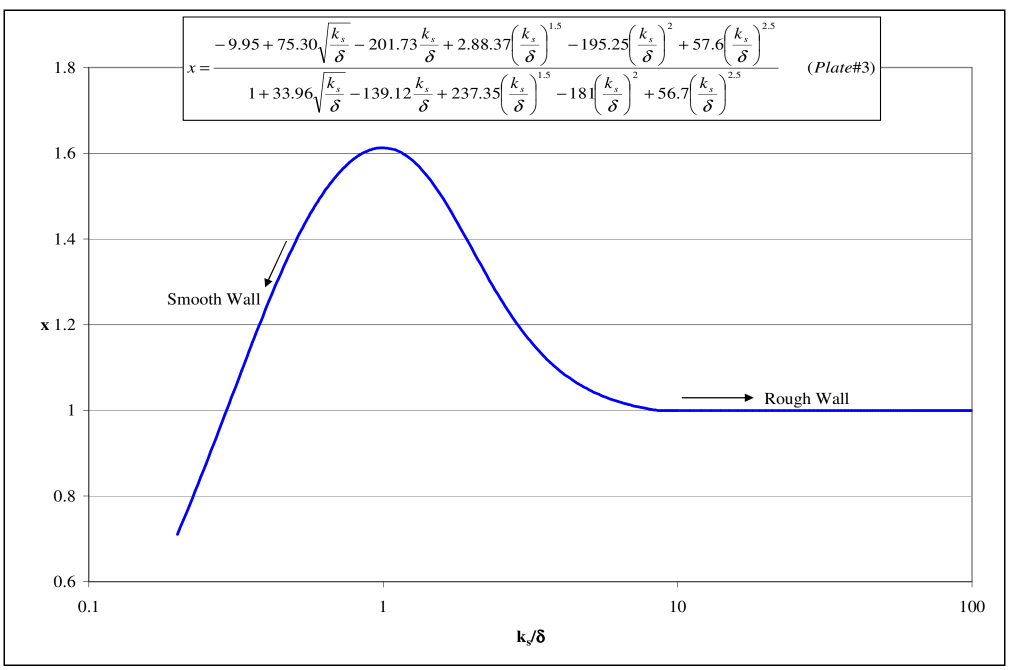


Figure 2.4 – x versus ks/δ.

x = dimensionless parameter representing a relative roughness;

k_s= effective roughness d_{65} (mm);

δ = measured suspended sediment load (mm);

3. Calculate the percent of flow sampled (P_{fs}) by the depth integrated sampler based on the transport parameter (P), which is a function of the relative roughness (x) and the ratio of the unmeasured depth over the measured depth (A').
4. Calculate the sediment load for the sampled zone. Equations have been formulated to determine percent flow sampled based on transport parameter.

$$Q'_{s\,total} = Q_s \; P_{fs} \qquad \text{(Eq 2.2)}$$

Where:
P_{sf} = *Percent Flow Sampled*

Q'_{stotal} = *Total suspended sediment load in sampled zone*

5. Determine the suspended sediment load for each size fraction by partitioning the sampled suspended load.

$$Q'_{si} = Q'_{stotal} \; i_s \qquad \text{(Eq 2.3)}$$

Where:
i_s = *fraction of suspended material in a given size range; and*

Q'_{si} = *suspended sediment load by size fraction (tons/day).*

Next determine the bed load for each size fraction:

6. Use the data obtained from the bed material load to determine the bed load transport intensity (Φ_*) based on the maximum shear intensity (ψ_*) of flow acting on a given particle size class and the probability that the particles are entrained.

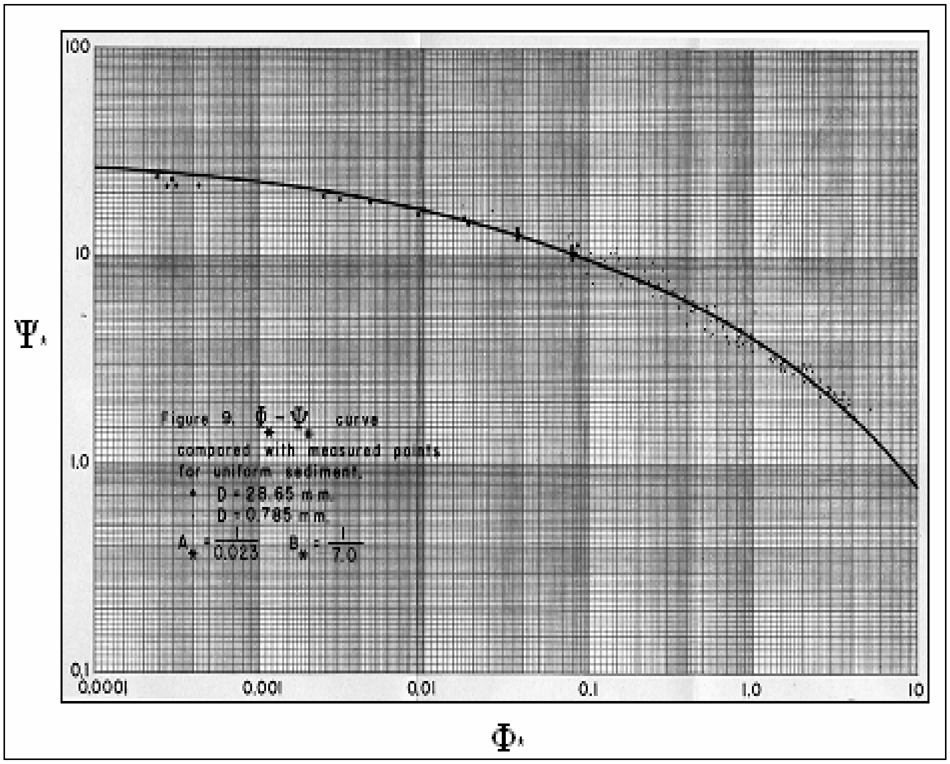


Figure 2.5 – Shear Intensity versus Bed Load Transport Intensity (Einstein, 1950)

7. Determine the bed load for each size class.

$$Q_{Bi}^{'} = 1200 d_i^{1.5} i_B \frac{\phi_*}{2}(43.2W) \quad \text{(Eq 2.4)}$$

Where:

$Q_{Bi}^{'}$ = *sediment load by size fraction through the bed layer; and*

d_i = *geometric mean diameter of a size range (ft);*

i_b = *fraction of bed material in a given size range; and*

ϕ_* = *intensity of bedload transport for individual grain size.*

W = *channel width (ft).*

Finally, the total load can be calculated by taking the sum of the measured and unmeasured load. Using the measured sediment data the total load is calculated:

8. Based on the suspended sediment load and the bed material load for each size fraction, an initial guess for the Rouse number (z) can be determined.

$$z_{guess} = -0.1465 \ln\left(\frac{Q_{si}^{'}}{Q_{Bi}{'}}\right) + 1.0844 \qquad \text{(Eq 2.5)}$$

Where:

z_{guess} = *Initial Rouse Number*

9. Using Einstein's (1950) integrals, an iterative calculation of the estimated z can be determined as a function of $I_1^{"}$, $J_1^{'}$, $J_1^{"}$, $-J_2^{'}$ and $-J_2^{"}$. This will result in a corrected z.

$$z_{calculated} = -0.1465 \ln \frac{I_1^{"}}{J_1^{"}}\left(PJ_1^{'} + J_2^{'}\right) + 1.0844 \qquad \text{(Eq 2.6)}$$

Where:

$z_{calculated}$ = *Calculated Rouse Number*

10. BORAMEP requires a minimum of two size classes to be transported by the suspended sediment and bed material modes of transport. If this does not occur, then the program will not calculate a total load.

11. Fall velocity (ω) is calculated by Rubey's (1933) equation.

$$\omega = \left\{ \left[\frac{2}{3} + \frac{36\,\nu^2}{g\,d^3\left(\frac{\gamma_s}{\gamma} - 1\right)} \right]^{1/2} - \left[\frac{36\,\nu^2}{g\,d^3\left(\frac{\gamma_s}{\gamma} - 1\right)} \right]^{1/2} \right\} \left[d\,g\left(\frac{\gamma_s - \gamma}{\gamma}\right) \right]^{1/2} \qquad \text{(Eq 2.7)}$$

Where:

ω = *Fall velocity*

ν = viscosity

d = mean particle diameter

g = gravity

γ = Specific Weight of Water

γ_s = Specific Weight of Sediment

12. A regression equation is developed to relate z to ω. Using the regression equation the z value can be determined for all size classes.

13. Total (measured and unmeasured) suspended sediment load is determined based on the fraction of suspended sediment.

$$Q_{si_{suspended}} = Q_{si}^{'} \frac{\left(P\,J_1^{''} + J_2^{''}\right)}{\left(P\,J_1^{'} + J_2^{'}\right)} \qquad \text{(Eq 2.8)}$$

Where:

$Q_{si_{suspended}}$ = Suspended Sediment Load for a given size class i

14. Total (measured and unmeasured) bed load is determined based on fraction of bed load in a given size class.

$$Q_{si_{bed}} = Q_{Bi}{'}\left(P\,I_1^{''} + I_2^{''} + 1\right) \qquad \text{(Eq 2.9)}$$

Where:

$Q_{si\,bed}$ = Bed Load for a given size class i

15. The total load is calculated by summing the suspended loads and bed load for each size class.

$$Q_{s_{total\,load}} = \sum Q_{si\ suspended} + \sum Q_{si\ bed} \quad \text{(Eq 2.10)}$$

Where:

$Q_{s_{total\,load}}$ = Total Load

For details of the equations used by the Bureau of Reclamation in the development of BORAMEP, refer to Appendix A.

To begin using the BORAMEP program, the user must specify the percent overlap between the measured suspended sediment and bed material. When zero is entered this suggests that overlap is not required to calculate the Rouse number. Figure 2.6 is a screen capture to show that the percent overlap is needed at the beginning of the program.

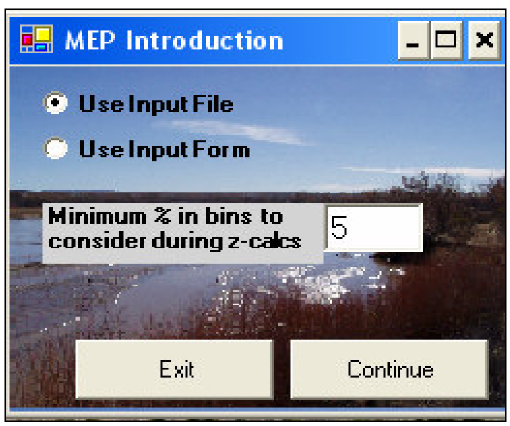


Figure 2.6 – Minimum Percent Overlap Input Sheet

In order for BORAMEP to calculate total sediment load, the program requires the input of measured data. If not all the data is available then the program cannot calculate a total load. Figure 2.7 depicts the necessary variables for calculation. The input sheet required an energy slope, but based on detailed analysis of the program it is not used to determine total sediment load. The program considers particles smaller than 0.0625 mm as wash load and these particles are not considered in Rouse number (z value) calculation.

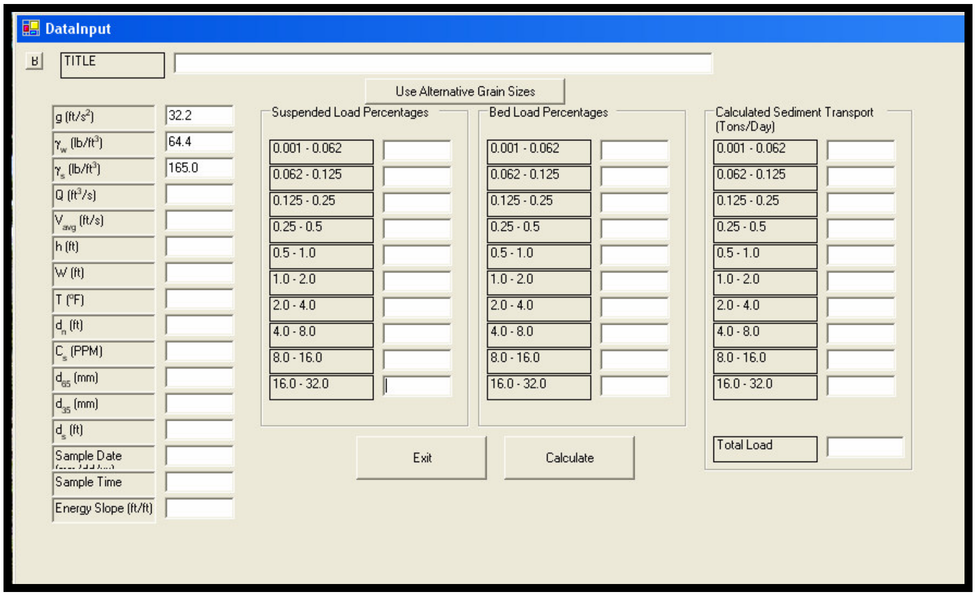


Figure 2.7 – Data Input Sheet for BORAMEP

In order to aid the user, the program developers added error messages. The following are a list of error messages provided in the current version of BORAMEP:

1. Fitted z-value generated a negative exponent, not continued.
2. Failed to converge to z during MEP.
3. Not enough overlapping bins for MEP.
4. There is an error during file input.
5. Unknown error occurred during MEP.
6. Unknown error, attempting to continue.

When the program states that the “Fitted z-value generated a negative exponent, not continued,” the program total load will not be calculated. This means that the regression equation developed between the rouse number and the fall velocity generated a negative trend. This error occurs when the sediment concentration profile is greater above the bed. When the program states that “Failed to converge to z during MEP”, the program total load will not be calculated. This occurs because the calculated z value was determined to be zero. When the program states, “Not enough overlapping bins for MEP”, the total load will not be calculated. This message occurs when the size distribution for the measured suspended sediment and bed material do not overlap. BORAMEP requires that at least two sediment sample bins larger than 0.0625 mm overlap. When the program states, “there is an error during input”, the program will not calculate a total load. This occurs because data is missing in the input sheet. The other errors are self explanatory.

Finally, figure 2.8 provides a flow schematic of how BORAMEP works.

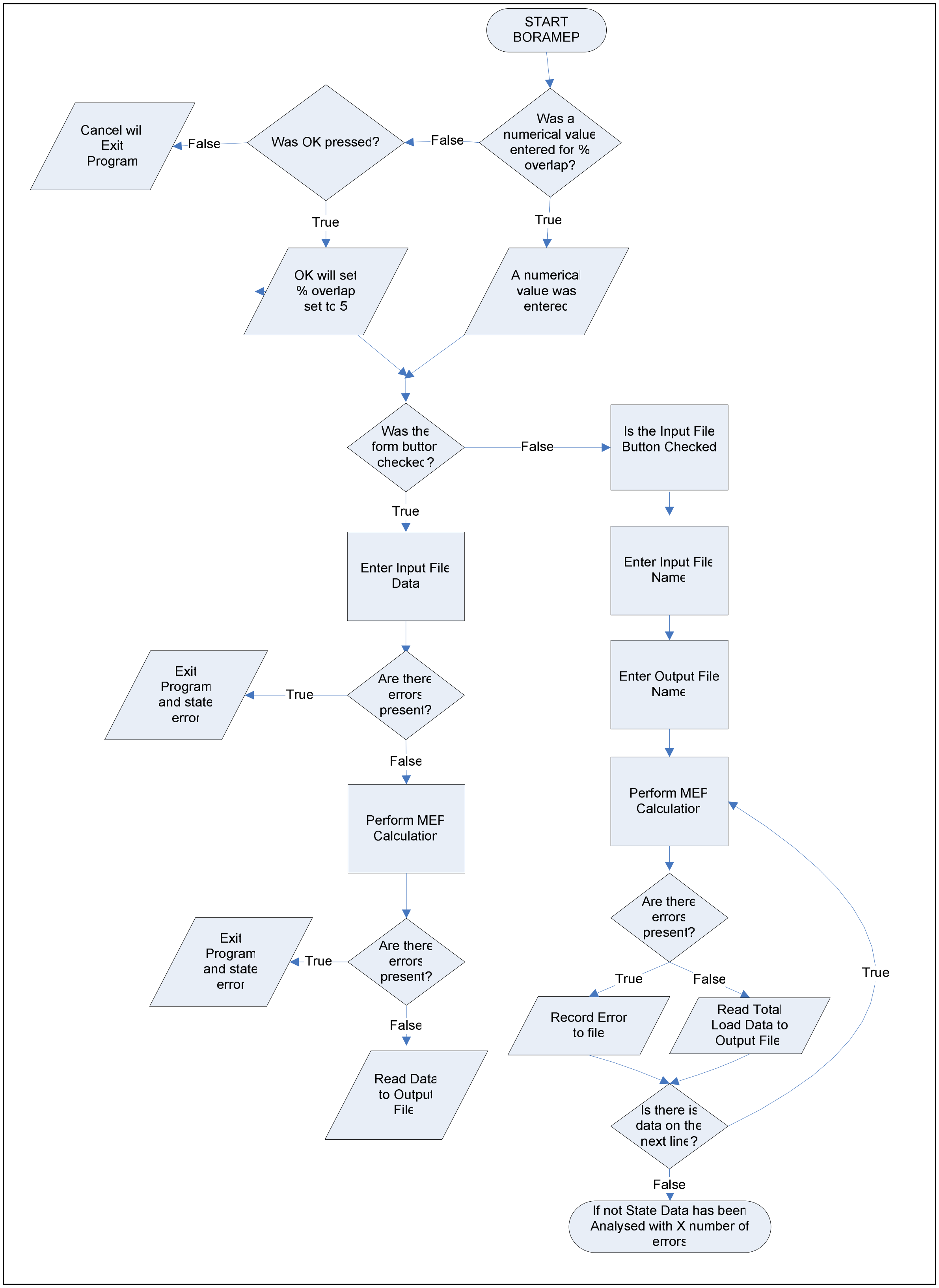


Figure 2.8 – Flow diagram of BORAMEP

Chapter 3: Previous Application of BORAMEP on the Low Flow Conveyance Channel

3.1 Introduction

BORAMEP was used in 2004 by Albert to calculate the total sediment load in the Corrales Reach of the Rio Grande River. The calculated values were inconsistent with measured values, which led to initial BORAMEP testing on the LFCC. The LFCC was used to test BORAMEP because the USBR had plenty of readily available data to compare calculated total loads with measured total loads. In 2001 the USBR collected suspended sediment, bed material, channel hydraulic and geometry data on the LFCC. Table 3.1 provides a list of the three cross sections that were sampled. Each cross section (LF-11, LF-25 and LF-39) was sampled on three distinct occasions (A, B and C) at 300 cfs and 600 cfs, respectively. In addition, total sediment data were collected at two sampling sills located at the Vehicle Bridge and Foot Bridge (LF-VB and LF-FB). Data at the sampling sills were collected seven times at 300 cfs and twelve times at 600 cfs. Appendix B contains a map identifying the location of these cross sections.

Table 3.1 – Cross Section Samples

Cross Section	Flow Rate (cfs)	Sample Date	Sample Time		
			A	B	C
LF – 11	300	6/8/2001	11:30 AM	4:00 PM	5:50 PM
LF - 25	300	6/11/2001	2:45 PM	8:00 PM	6:40 PM
LF - 39	300	6/9/2001	2:50 PM	10:30 AM	5:12 PM
LF – 11	600	5/27/2001	11:30 AM	4:20 AM	Not Available
LF - 25	600	5/28/2001	11:38 AM	5:10 PM	10:45 AM*
LF - 39	600	5/30/2001	3:45 PM*	9:45 AM	12:30 PM

* These data were sampled on May 29th 2001

Jay (2005) used the Bureau of Reclamation Automated Modified Einstein Procedure (BORAMEP) on the LFCC to determine the effectiveness of the program's capability to calculate total sediment load in sand bed channels. The USBR provided the necessary data at the three cross sections. The data for each cross section were collected in seven vertical sections (Figure 3.1) that were analyzed individually and as a whole. Each sample had a unique label to clearly identify the location: LF-25B-25-30. The label states that this sample is taken at low flow section 25, sample B and the vertical was between stations 25 and 30 ft on the cross section. Appendix C contains input sheets. Figure 3.1 depicts a sample of a cross section; the numbers represent the station of a given vertical. For example, 20-32 refers to the vertical from 20 feet to 32 feet.

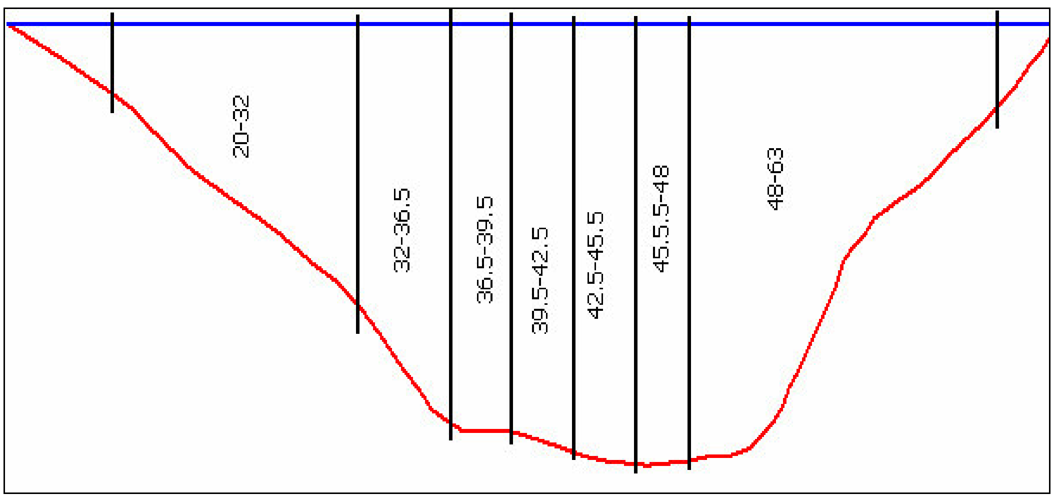


Figure 3.1 – Cross Section and Vertical Representation

Jay (2005) developed four distinct methods to calculate total sediment load. Method A uses BORAMEP to determine the sediment load at each vertical. Method B separates the verticals between mobile bed and riprap side sections. Sediment load within the mobile bed is calculated using BORAMEP and a suspended sediment equation is used within the riprap sections.

$$Q_s = fQC \qquad \text{Eq 3.1}$$

Where:

Q_s = *suspended sediment load (tons/day);*

f = *conversion factor of 0.0227;*

Q = *discharge (cfs);*

C = *suspended sediment concentration (mg/l).*

Method C only uses the suspended sediment load equation to determine the sediment load at each vertical. In this condition it is assumed that suspended sediment load is equal to total sediment load. The suspended sediment load equation is applicable because in many sand bed channels the majority of sediment transport is located in the suspended sediment section. The total sediment loads calculated for methods A, B, and C are summed to determine the overall total sediment load at the cross sections for the respective method. Finally, method D is a cross sectional average method used to determine the total load. This method determines average inputs for each cross section. All four methods are evaluated at a zero percent overlap between the suspended sediment and bed material to evaluate the z value.

3.2 Results and Discussion

Based on measurements collected at each cross section, total sediment load was calculated for a discharge of 300 and 600 cfs. On occasion error messages were encountered and BORAMEP could not calculate a sediment load. Under these conditions equation 3.1 was used to calculate the total load assuming that there is negligible bed load, hence all load is found in suspension.

3.2.1 Method A

The BORAMEP Method A was completed (see Appendix D: BORAMEP Method A). Refer to Table 3-2 for a summary of the results from Method A.

Table 3-2 – Total Load Results from Method A[1]								
	Method A--300 cfs				Method A--600 cfs			
X Sec	Q cfs	Total Load tons/day	Suspended Load tons/day	Bed Load tons/day	Q cfs	Total Load tons/day	Suspende d Load tons/day	Bed Load tons/day
11A	280	352	302	50	621	1123	1028	95
11B	273	220	206	14	595	1036	978	58
11C	262	229	193	36	579	1012	930	82
25A	281	1284	1159	125	587	514	496	18
25B	272	1312	1187	125	566	498	474	24
25C	287	1232	1177	55	573	481	460	21
39A	287	154	129	25	603	411	391	20
39B	277	138	123	15	571	400	360	40
39C	290	163	129	34	570	456	354	102

During the analysis there were errors resulting in the generation of a negative z exponent and not enough overlapping bins. Therefore, to determine total load the suspended sediment equation was used to calculate the load for verticals that resulted in errors during calculations. The data indicate that less than twenty percent of the total load is associated with bed load.

[1] Source: Low Flow Conveyance Channel BORAMEP total load analysis 2001, Jay 2005

3.2.2 Method B

Method B uses a combination of the suspended sediment equation (riprap side slopes) and BORAMEP (mobile bed) to determine the total sediment load. Table 3.3 provides a summary of the cross section stations that are considered to be located in the mobile bed section of the sample.

Table 3.3 – Left and Right Endpoints of Mobile Bed Section			
Cross Section	**Left/Right endpoints of mobile bed section (ft)**		
	From Survey Data	**Q = 300 cfs**	**Q = 600 cfs**
LF-11	32 - 50	32 - 48	34 - 50
LF-25	20 - 56	25 - 54	21 - 57
LF-39	24 - 64	29 - 56	20 - 62

The total sediment load using Method B is summarized in Tables 3.4 and 3.5. For additional detail on this method refer to Appendix E.

Table 3.4 – Total Load Results from Method B at 300 cfs[2]								
X Sec	**Total Q cfs**	**Mobile Bed Section**				**Rip Rap Side Slope**		**Total Load tons/day**
		Q cfs	**Total Load tons/day**	**Suspended Load tons/day**	**Bed Load tons/day**	**Q cfs**	**Suspended Load = Total Load tons/day**	
11A	280	181	240	209	31	99	93	333
11B	273	173	146	136	10	100	69	216
11C	262	184	157	128	29	78	65	222
25A	281	220	1,128	1,002	126	61	156	1,284
25B	272	217	1,081	955	126	55	231	1,312
25C	287	214	949	894	55	73	283	1,232
39A	287	201	117	92	25	86	37	154
39B	277	191	98	83	15	86	40	138
39C	290	199	123	89	34	91	40	163

[2] Source: Low Flow Conveyance Channel BORAMEP total load analysis 2001, Jay 2005

Table 3.5 – Total Load Results from Method B at 600 cfs[3]								
X Sec	Total Q cfs	Mobile Bed Section			Rip Rap Side Slope			Total Load tons/day
		Q cfs	Total Load tons/day	Suspended Load tons/day	Bed Load tons/day	Q cfs	Suspended Load = Total Load tons/day	
11A	621	363	722	633	89	258	394	1,117
11B	595	349	617	615	2	246	362	979
11C	579	345	667	592	75	234	337	1,003
25A	587	474	432	413	19	113	82	514
25B	566	460	416	392	24	106	82	498
25C	573	459	397	376	21	114	84	481
39A	603	522	360	339	21	81	52	411
39B	571	499	357	317	40	72	43	400
39C	570	495	414	312	102	75	42	456

As expected the majority of the sediment load is found in the suspended section of the mobile bed. However, error messages were encountered in the mobile bed section calculations associated with a negative z exponent and not enough overlapping bins. Therefore, to determine total load the suspended sediment equation (Eq 3.1) was used to calculate the load for verticals, which resulted in error messages.

[3] Source: Low Flow Conveyance Channel BORAMEP total load analysis 2001, Jay 2005

3.2.3 Method C

The total sediment load using Method C is summarized in Table 3.6. For additional detail on this method refer to Appendix F.

Table 3.6 – Suspended Sediment Load from Method C[4]

X Sec	Method C--300 cfs			Method C--600 cfs		
	Date	Q (cfs)	Suspended Load (Ton/day)	Date	Q (cfs)	Suspended Load (Ton/day)
11A	6/8/2001	280	302	5/27/2001	621	1,027
11B	6/8/2001	273	206	5/27/2001	595	978
11C	6/8/2001	262	193	5/27/2001	579	929
25A	6/11/2001	281	1,158	5/28/2001	587	495
25B	6/11/2001	272	1,186	5/28/2001	566	474
25C	6/11/2001	287	1,176	5/29/2001	573	460
39A	6/9/2001	287	129	5/29/2001	603	390
39B	6/9/2001	277	123	5/30/2001	571	360
39C	6/9/2001	290	129	5/30/2001	570	354

This method does not utilize BORAMEP. It takes the measured suspended sediment concentration from the point integrated sampler and converts it into a sediment load based on the known discharge. Method C assumes that all sediment load is in suspension and there is negligible sediment load located in the bed layer.

4 Source: Low Flow Conveyance Channel BORAMEP total load analysis 2001, Jay 2005

3.2.4 Method D

The total sediment load calculated using Method D is summarized in Table 3.7. For additional detail on this method refer to Appendix G.

Table 3.7 – Total Load Results from Method D[5]

X Sec	Method D - 300 cfs				Method D - 600 cfs			
	Q cfs	Total Load tons/day	Suspended Load tons/day	Bed Load tons/day	Q cfs	Total Load tons/day	Suspended Load tons/day	Bed Load tons/day
11A	280	351	298	53	621	1,424	987	437
11B	273	212	212	0	595	926	926	0
11C	262	179	179	0	579	1,228	874	354
25A	281	1,238	1,190	48	587	509	479	30
25B	272	907	909	-2	566	474	456	18
25C	287	1,254	1,232	22	573	528	448	80
39A	287	189	131	58	603	431	389	42
39B	277	154	122	31	571	398	353	45
39C	290	179	134	45	570	377	341	36

Cross Section LF-11B and LF-11C at 300cfs and LF-11B at 600cfs resulted in an error. The program (BORAMEP) indicated that a negative z value was generated. Thus the suspended sediment equation (Eq 3.1) was used to calculate the total load. An error is noticed at section 11-25B because the calculated suspended sediment load is greater than the total load at 300 cfs, this suggest that BORAMEP needs additional checks. The resulting total sediment load is significantly less than the load when errors were not encountered. The sediment load at cross section LF-25 at 300 cfs and LF-11 at 600 cfs seems to be out of place. This high sediment load can be caused by external factors on the day of analysis. High loads could be attributed to the LFCC not reaching equilibrium after a change in flow, or perhaps an error in data collection.

[5] Source: Low Flow Conveyance Channel BORAMEP total load analysis 2001, Jay 2005

3.2.5 Comparisons of Methods

A comparison was conducted on the four methods used to evaluate total load calculation. The total load calculation determined at 300 and 600 cfs for each methodology was compared against Method A. Tables 3.8 and 3.9 contain a summary table of the results.

Table 3.8 – Total Load Comparison at 300cfs to Method A[6]

CR-Sec	Q (cfs)	Method A	Method B		Method C		Method D	
		Total Load (Ton/day)	Total Load (Ton/day)	% of Method A	SS Total Load (Ton/day)	% of Method A	Total Load (Ton/day)	% of Method A
LF-11A	280	352	333	95%	302	86%	351	100%
LF-11B	273	220	216	98%	206	93%	212	96%
LF-11C	262	229	222	97%	193	84%	179	78%
LF-25A	281	1284	1284	100%	1158	90%	1238	96%
LF-25B	272	1312	1312	100%	1186	90%	907	69%
LF-25C	287	1232	1232	100%	1176	96%	1254	102%
LF-39A	287	154	154	100%	129	83%	189	122%
LF-39B	277	138	138	100%	123	89%	154	111%
LF-39C	290	163	163	100%	129	79%	179	110%

Table 3.9 – Total Load Comparison at 600cfs to Method A[7]

CR-Sec	Q (cfs)	Method A	Method B		Method C		Method D	
		Total Load (Ton/day)	Total Load (Ton/day)	% of Method A	SS Total Load (Ton/day)	% of Method A	Total Load (Ton/day)	% of Method A
LF-11A	621	1123	1117	99%	1027	91%	1424	127%
LF-11B	595	1036	979	95%	978	94%	926	89%
LF-11C	579	1012	1003	99%	929	92%	1228	121%
LF-25A	587	514	514	100%	495	96%	509	99%
LF-25B	566	498	498	100%	474	95%	474	95%
LF-25C	573	481	481	100%	460	96%	528	110%
LF-39A	603	411	411	100%	390	95%	431	105%
LF-39B	571	400	400	100%	360	90%	398	99%
LF-39C	570	456	456	100%	354	78%	377	82%

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[6] Source: Low Flow Conveyance Channel BORAMEP total load analysis 2001, Jay 2005

[7] Source: Low Flow Conveyance Channel BORAMEP total load analysis 2001, Jay 2005

As shown in Tables 3.8 and 3.9, the total sediment load is equivalent for Methods A and B for LF-25 and LF-39 under both flow regimes. This suggests that BORAMEP could not calculate total load at the riprap side slopes, thus the suspended sediment equation was used. In addition, the other errors that occurred in the mobile bed section in Method A and B are consistent, resulting in the same output. When comparing Method A to Method C the total sediment load is always lower because Method C only accounts for suspended load. As a result the total sediment load is underestimated. The total sediment load in Method D does not follow a pattern. At certain cross sections the total load was calculated to be higher, whereas at other cross section the load tends to be lower.

From the data in Tables 3.8 and 3.9, total load results from each method at 300 cfs and 600 cfs were plotted for all samples (A, B and C) at each cross section (11, 25 and 39) and for each methodology (A, B, C and D). Refer to Figures 3.2 and 3.3 for bar graphs representing the sediment load.

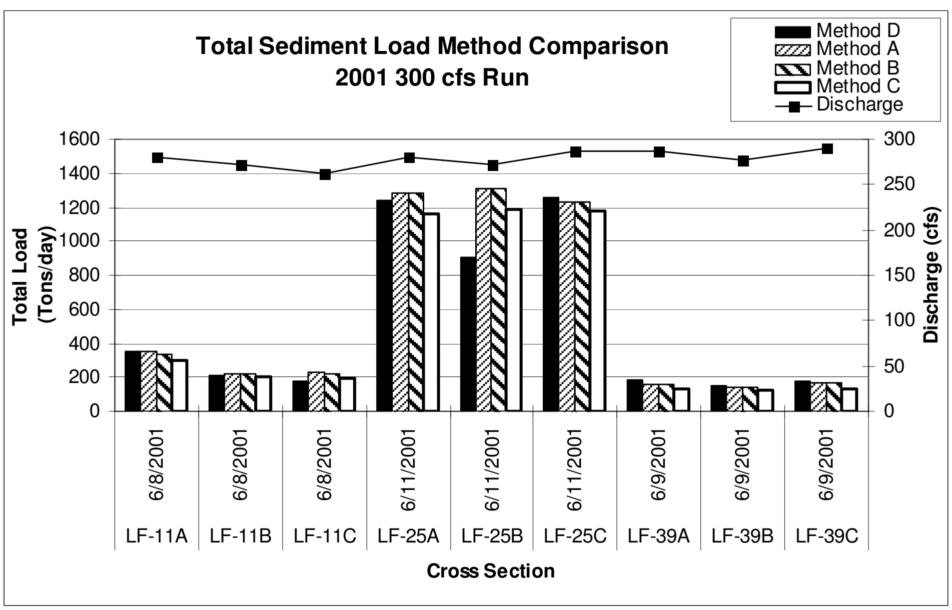

Figure 3.2 – Total Sediment Load Method Comparison 300 cfs Run[8]

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[8] Source: Low Flow Conveyance Channel BORAMEP total load analysis 2001, Jay 2005

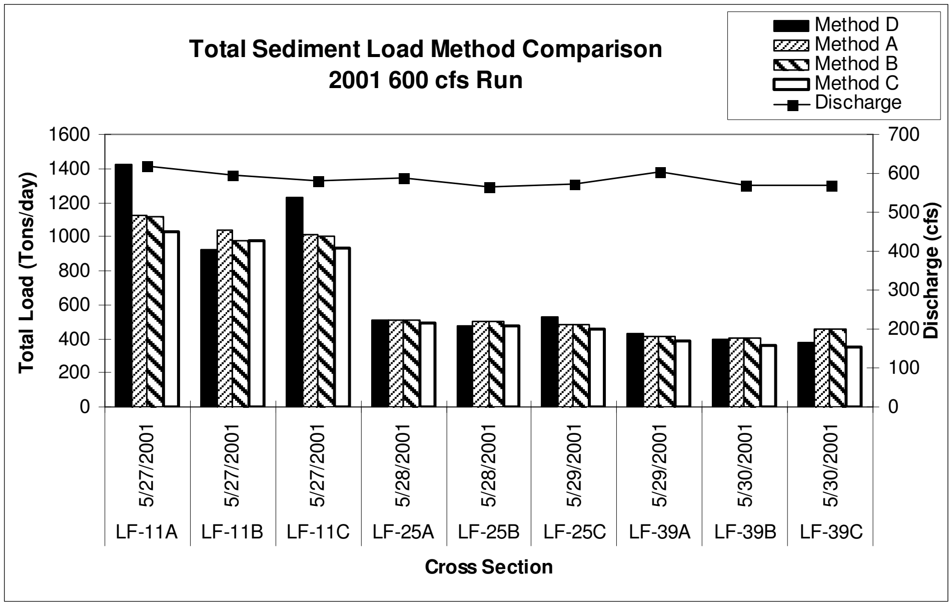

Figure 3.3 – Total Sediment Load Method Comparison 600 cfs Run[9]

These graphs help depict the variability and similarity in determining total sediment load for each method.

3.3 Comparison of BORAMEP to Sampling Sills

Two sampling sills are located at the Foot Bridge (LF-FB) and Vehicle Bridge (LF-FB) (the relative locations of these sampling sills can be found on the maps contained in Appendix B). Depth integrated and point samplers were used at the sampling sills to calculate total sediment, with a tolerance of 0.05 to 0.1 feet. The suspended sediment concentrations (mg/L) at the sampling sills were multiplied by the approximate flow rate (300 and 600 cfs) and the appropriate conversion factor (0.0027) to give an estimate of the total load (in tons per day) at the sampling sills. Since the total load determined by methods A, B, C and D are somewhat similar, only Method A is compared to the sampling sills.

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[9] Source: Low Flow Conveyance Channel BORAMEP total load analysis 2001, Jay 2005

The total load estimates from the sampling sills were compared to the total load estimates from BORAMEP (Method A) by plotting the total load and the flow rate (Figure 3.4).

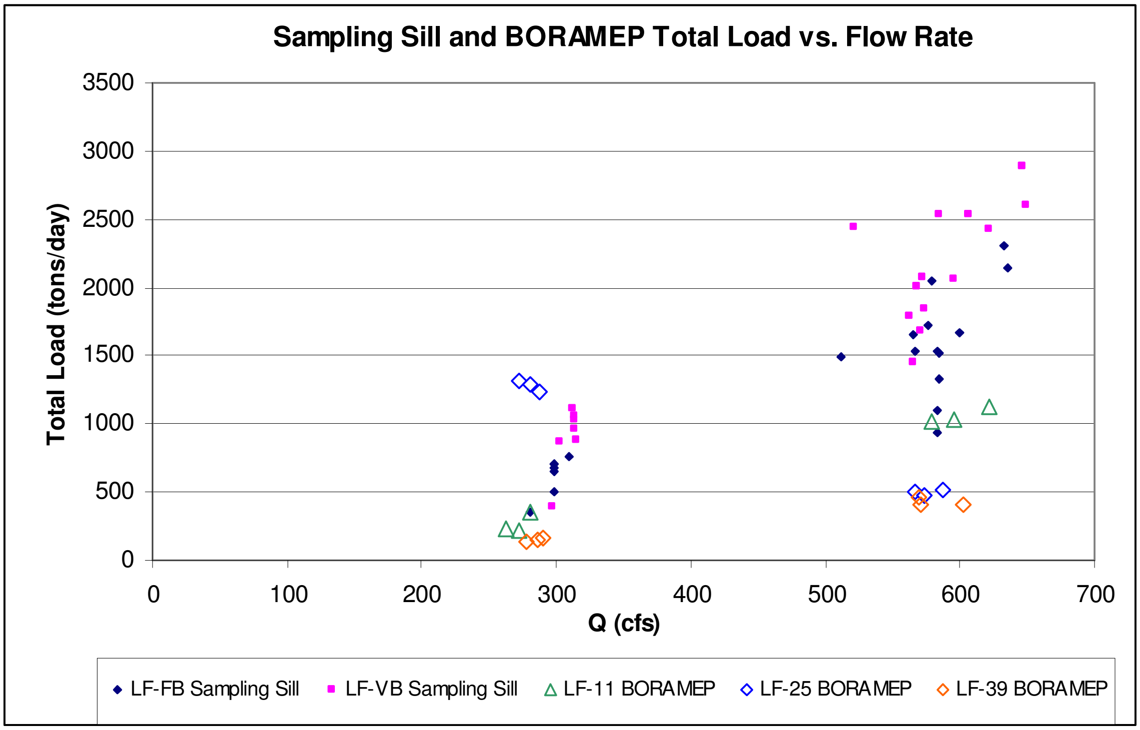

Figure 3.4 – Sampling Sill and BORAMEP Total Load vs. Flow Rate[10]

From Figure 3.4, the BORAMEP results from Method A (LF-11, LF-25, and LF-39) are bound by the sediment load measured at the sampling sills at 300 cfs; but at 600 cfs the calculated total sediment load seems to underestimate the total sediment load when compared to the sampling sills. The data results show a sediment sample error occurred on June 11, 2001. There could also have been errors on the other sampling dates, which skewed the data. When using suspended load equation, only the total load is under estimated. The location and distance of the sampling sill (LF-VB and LF-FB) with respect to the cross sections (LF-11, LF-25 and LF-39) could potentially result in total loads that do not match.

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[10] Source: Low Flow Conveyance Channel BORAMEP total load analysis 2001, Jay 2005

Chapter 4: Variability of Total Load

4.1 Introduction

BORAMEP was developed to determine the total sediment load in sand bed channels. The results of previous total sediment load studies on the Middle Rio Grande and the LFCC (Chapter 3) using BORAMEP suggested additional analysis is necessary on the LFCC. Thus the USBR requested that a variability analysis be performed on BORAMEP to explain why errors were occurring during calculations and to determine the programs limitations. This thesis focuses on determining the variability of total load calculated by BORAMEP by performing a variability analysis based on data from the LFCC.

The first objective was to determine the most suitable cross section, vertical profiles and percent overlap to test the variability of BORAMEP. In Chapter 3 the LFCC was analyzed at cross sections LF-11, LF-25 and LF-39 at 300 and 600 cfs three times each. From the data the most suitable cross section was selected. Then the percent overlap was varied for each vertical between the suspended sediment and bed material samples from 0 to 5% for the selected cross section. Then the verticals with the fewest errors were further used in testing BORAMEP.

The second objective was to determine, which parameters within BORAMEP are variable. Based on the parameters, 15 permutations were developed. The program analysis suggested that the following parameters are varied: flow depth, top width, discharge, mean flow velocity, concentration, vertical sampling distance, d_{35}, d_{65}, and water temperature. Each permutation included changing one to three of these parameters.

Finally, based on the parameterizations, discrepancies within the program were identified and additional error messages were suggested. Additional constraints were also recommended to improve the code. This information will improve the usability of the existing program.

4.2 Selection of Cross Section, Optimal Vertical Profile and Percent Overlap

The total load analysis of the LFCC indicated that the most suitable cross section was LF-11 at 300 cfs. This was because total load measured at the two sampling sills (LF-FB and LF-VB) were closest to the calculated total load at LF-11 (Refer to Table 4.1)

Table 4.1 – Average Total Load Summary Table

Type of Site	Location	Average Total Load (tons/day)
Cross Sections	LF-11	267
	LF-25	1276
	LF-39	152
Sampling Sills	LF-FB	620
	LF-VB	900

Next, Table 4.2 was developed to determine the best verticals and percent overlap to use in testing BORAMEP. In the table, the highlighted verticals indicate the location of the riprap side slope at this sample. The blank cells in the matrix indicate scenarios where total load was calculated by BORAMEP. In order for the program to run, a minimum of two size classes must overlap between the suspended sediment and bed material samples, otherwise the program will terminate and an error indicating that there are not enough overlapping bins will occur. In addition, if the measured suspended sediment particle distribution is significantly greater than the bed material sample, then the program will terminate and an error message will indicate that the fitted z value generated a negative exponent and a total load could not be calculated.

Table 4.2 – Varying Minimum Overlap for Size Classes During z Calculation																						
Minimum % in bins to consider during z-calculations	LF-11A-20-32	LF-11A-32-36.5	LF-11A-36.5-39.5	LF-11A-39.5-42.5	LF-11A-42.5-45.5	LF-11A-45.5-48	LF-11A-48-63	LF-11B-20-32	LF-11B-32-36.5	LF-11B-36.5-39.5	LF-11B-39.5-42.5	LF-11B-42.5-45.5	LF-11B-45.5-48	LF-11B-48-63	LF-11C-20-32	LF-11C-32-36.5	LF-11C-36.5-39.5	LF-11C-39.5-42.5	LF-11C-42.5-45.5	LF-11C-45.5-48	LF-11C-48-63	# of Errors
5	0	0	0	0	0	0		0	0	0	0		0			0	0	0	0	0		16
4	0	0	0	0	0	0		0	0		0		0			0	0	0	0	0		15
3	0	0	0	0	0	0		0			0		z				0		0	0		11
2	0							0					z						0			4
1.5	0							0					z									3
1.4	0							0					z									3
1.35	0							0					z									3
1.3	0							z					z									3
1.25	0							z					z		z							4
1	0							z					z		z							4
0		z						z		z	z		z		z							6

0 = Not Enough Overlapping Bins for the Modified Einstein Procedure
z = Fitted Z-value generated negative exponent, program could not continue.

Table 4.3 was developed to determine how the total sediment loads vary. Blank cells indicate that an error occurred, which stopped the program before a total load was calculated.

Table 4.3 – Total Load calculation at each vertical

Station Location	Discharge (cfs)	Minimum % in bins to consider during z-calculations											Ave Total Load (tons/day)
		5	4	3	2	1	1.5	1.4	1.3	1.25	1	0	
LF-11A-20-32	38.1											41.7	41.7
LF-11A-32-36.5	51.5				78.3	78.3	78.3	78.3	78.3	78.3	76.5		78.1
LF-11A-36.5-39.5	35.8				45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6	45.6
LF-11A-39.5-42.5	35.3				61.5	57.6	57.6	57.6	57.6	57.6	57.6	57.6	58.1
LF-11A-42.5-45.5	32.2			47.2	47.2	43	43	43	43	43	43	43	43.9
LF-11A-45.5-48	26.4				33.5	33.5	33.5	33.5	33.5	33.5	33.5	32.3	33.4
LF-11A-48-63	53.5	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	69.9	63.9
Total	**272.7**												364.7
Station Location	**Discharge (cfs)**	**Minimum % in bins to consider during z-calculations**											**Ave Total Load (tons/day)**
		5	**4**	**3**	**2**	**1**	**1.5**	**1.4**	**1.3**	**1.25**	**1**	**0**	
LF-11B-20-32	33.2												
LF-11B-32-36.5	46.1			44.8	44.8	44.8	44.8	44.8	42.3	42.3	42.3	42.3	43.7
LF-11B-36.5-39.5	32.5		41.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4		34.3
LF-11B-39.5-42.5	32.6				33.8	33.8	32.4	32.4	32.4	32.4	32.4		32.8
LF-11B-42.5-45.5	34.6	30.1	30.1	30.1	30.1	30.1	28.5	28.5	28.5	28.5	28.5	28.5	29.2
LF-11B-45.5-48	26.8												
LF-11B-48-63	56.4	47.7	47.7	47.7	47.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49
Total	**262.1**												**Missing Data**
Station Location	**Discharge (cfs)**	**Minimum % in bins to consider during z-calculations**											**Ave Total Load (tons/day)**
		5	**4**	**3**	**2**	**1**	**1.5**	**1.4**	**1.3**	**1.25**	**1**	**0**	
LF-11C-20-32	35.1	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7				33.7
LF-11C-32-36.5	49.1			38.5	38.5	38.5	36.4	36.4	36.4	36.4	36.4	41.4	37.7
LF-11C-36.5-39.5	35.6				26.7	24.7	24.7	24.7	24.7	24.7	24.7	24.9	25
LF-11C-39.5-42.5	35.3			40.1	35.8	35.8	35.8	35.8	35.8	35.8	35.8	33.3	36
LF-11C-42.5-45.5	35.5					34.4	34.4	34.4	34.4	34.4	34.4	33.1	34.2
LF-11C-45.5-48	28.8				24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.5	24.8
LF-11C-48-63	60.7	49	49	49	49	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.5
Total	**280.2**												239.8

Refer to Appendix I for output table of the variation of percent overlap for cross section 11

Using the data in Table 4.3, line graphs were developed to show the variation in total sediment concentration at the different percent overlap. Figures 4.1, 4.2 and 4.3 represent the sediment concentration at each vertical for a given percent overlap for samples 11A, 11B and 11C, respectively.

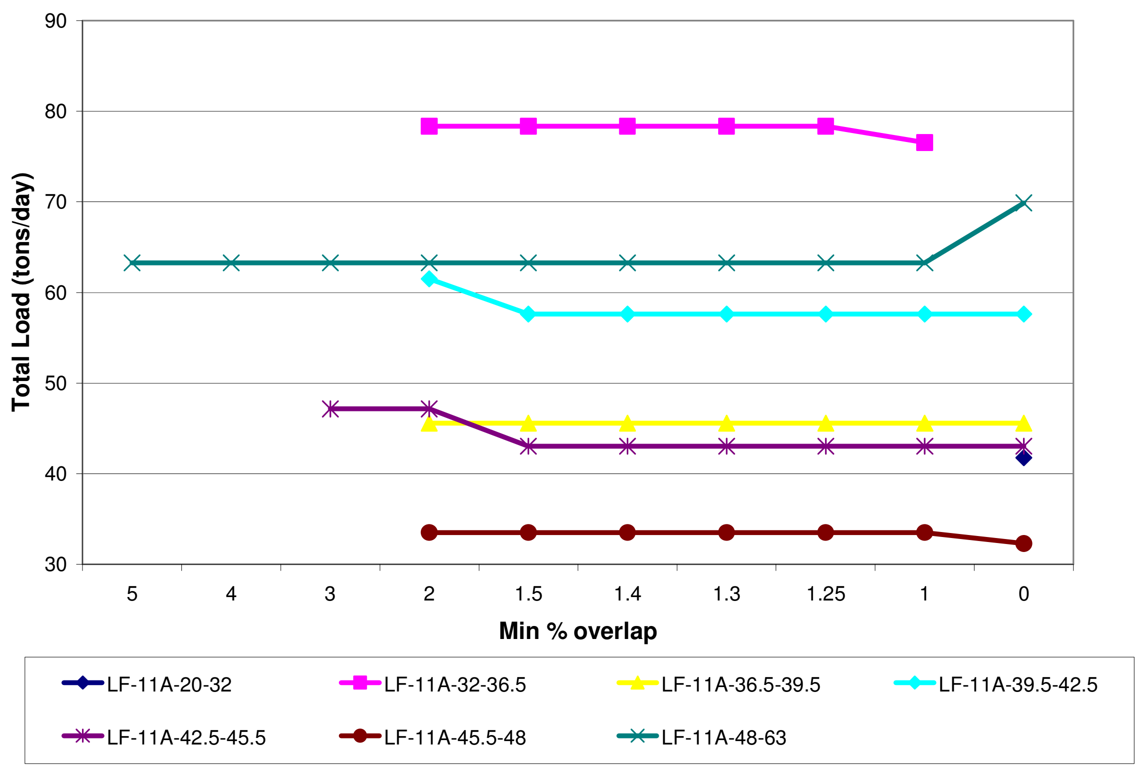

Figure 4.1 – Total Load for verticals of Sample "11-A" at various percent overlap

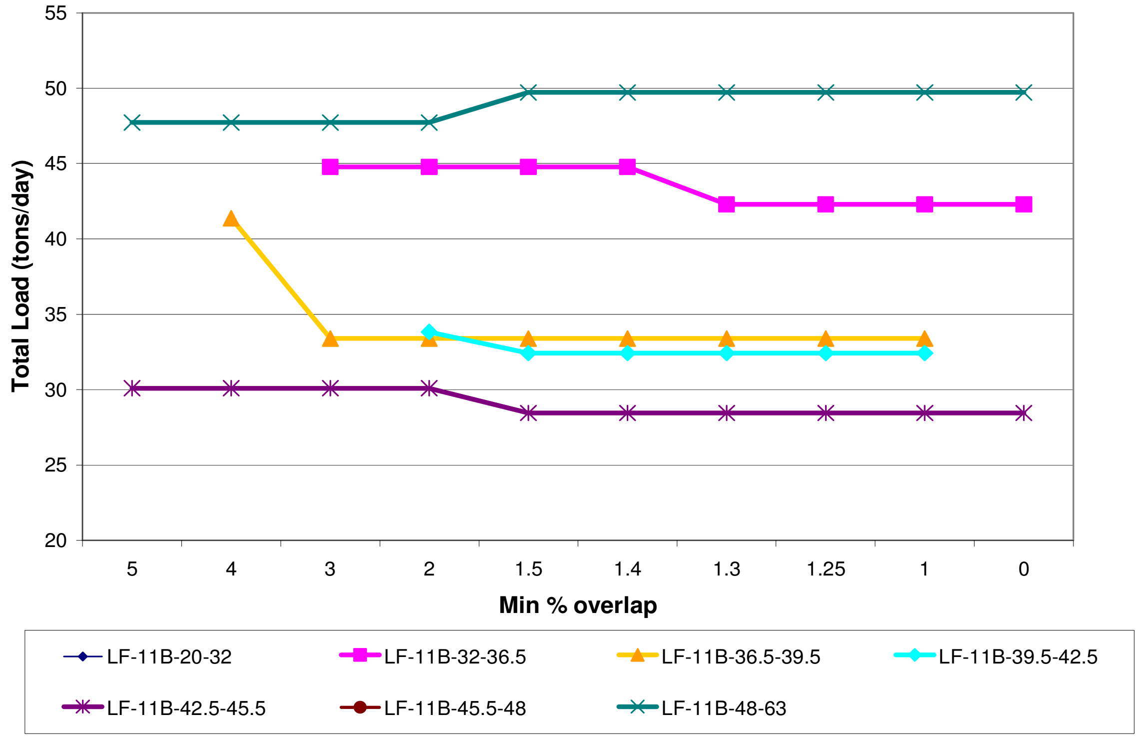

Figure 4.2 – Total Load for verticals of Sample "11B" at various percent overlap

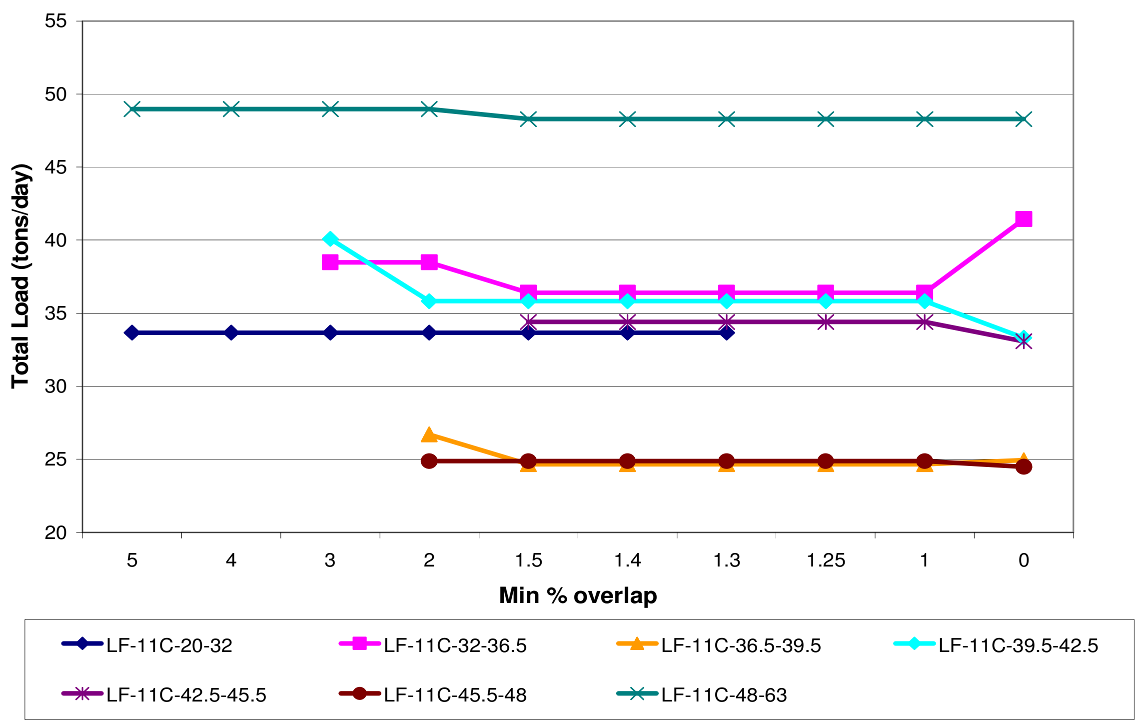

Figure 4.3 – Total Load for verticals of Sample "11C" at various percent overlap

The figures show that the total load varies slightly based on the percent of overlap. Minimal errors occurred between 1 and 2% overlap. The total sediment loads vary by less than 8 tons per day, which is less than 9% of the total load. Thus a percent overlap of 1.3% was used in all further analysis. From Table 4.2 and Figures 4.1, 4.2 and 4.3, the following verticals were chosen to further analyze in BORAMEP:

1. LF-11A (station 48 to 63)
2. LF-11B (station 42.5 to 45.5)
3. LF-11C (station 48-63)

The chosen verticals ran at all percentages of overlap, thus they were considered to be the optimal verticals to analyze.

4.3 Parameterization and Variability of BORAMEP

To determine the sensitivity of BORAMEP, parameters were varied. Table 4.4 provides a summary of the initial conditions for each vertical based on information provided by the USBR. The possible errors associated with measurement were not analyzed.

Table 4.4 – Initial Parameters

Parameters	LF-11A-48-63	LF 11B-42.5-45.5	LF-11C-48-63
Q (cfs)	53.535	26.808	60.688
V (ft/sec)	1.477	1.993	1.570
h (ft)	3.1	5.4	3.4
W (ft)	15	2.5	15
T (ºF)	72	72	72
S_f (ft/ft)	0.0008	0.0008	0.0008
d_s(ft)	2.8	5.1	3.1
d_n (ft)	0.3	0.3	0.3
C (ppm)	392.48	298.62	255.38
d_{65} (mm)	0.2	0.22	0.22
d_{35} (mm)	0.15	0.17	0.16

Different parameters were altered for each scenario. However, suspended sediment and bed material sampled particle distribution were held constant. Table 4.5

summarizes those values. Based on program analysis, the friction slope (S_f) was not used in any of the BORAMEP calculations, but the program requires a value be inputted.

Table 4.5 – Percent of Particle in Each Size Class							
Bin #	Size Class Range	Suspended Sediment Sample			Bed Material Sample		
		LF-11A 48-63	LF-11B 42.5-45.5	LF-11C 48-63	LF-11A 48-63	LF-11B 42.5-45.5	LF-11C 48-63
1	0.001 to 0.002	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	0.002 to 0.004	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
3	0.004 to 0.016	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
4	0.016 to 0.0625	61.15%	73.05%	68.67%	2.81%	0.19%	1.50%
5	0.0625 to 0.125	17.20%	13.80%	17.11%	17.89%	5.72%	10.03%
6	0.125 to 0.25	11.66%	10.55%	8.49%	78.50%	92.48%	83.51%
7	0.25 to 0.5	2.77%	1.50%	1.75%	0.77%	1.60%	4.86%
8	0.5 to 1	7.22%	1.11%	3.98%	0.02%	0.01%	0.04%
9	1 to 2	0.00%	0.00%	0.00%	0.02%	0.00%	0.02%
10	2 to 4	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%
11	4 to 8	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
12	8 to 16	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
13	16 to 32	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
14	32 to 64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
15	64 to 128	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
16	128 to 256	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

The following list shows, which parameters were varied in each permutation.

Permutation 1 – Concentration

Permutation 2 – d_{35}

Permutation 3 – d_{65}

Permutation 4 – Water Temperature

Permutation 5 – Total Depth

Permutation 6 – Discharge

Permutation 7 – Velocity

Permutation 8 – Width

Permutation 9 – Flow Depth and Discharge

Permutation 10 – Flow Depth and Velocity

Permutation 11 – Flow Depth and Measured Depth

Permutation 12 – Flow Depth, Flow and Measured Depth

Permutation 13 – Discharge and Velocity

Permutation 14 – Width and Discharge

Permutation 15 – Width and Velocity

Additional data on each case and parameter can be found in Appendix J. Tables 4.6A and 4.6B summarize the range of each variable used for each permutation.

Table 4.6A – Parameter Variation										
Case	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**[1]	
	C (ppm)	**d_{35} (mm)**	**d_{65} (mm)**	**T (F)**	**h (ft)**	**Q (cfs)**	**V_{avg} (ft/s)**	**W (ft)**	**h (ft)**	**Q (cfs)**
Case 1	0	0.001	0.001	0	0	0	0	0	0	0
Case 2	10	0.002	0.002	5	0.5	1	0.5	2.5	0.5	11.07621
Case 3	20	0.004	0.004	10	1	2	1	5	1	22.15241
Case 4	40	0.016	0.016	20	2	3	1.5	10	2	44.30483
Case 5	80	0.0625	0.0625	30	3	4	2	20	3	66.45724
Case 6	100	0.1	0.125	40	4	5	3	25	4	88.60966
Case 7	200	0.12	0.25	50	5	10	4	30	5	110.7621
Case 8	300	0.125	0.3	60	6	20	5	35	6	132.9145
Case 9	400	0.2	0.4	70	7	40	6	40	7	155.0669
Case 10	500	0.25	0.5	80	8	60	7	45	8	177.2193
Case 11	600	0.3	0.6	90	9	80	8	50	9	199.3717
Case 12	700	0.4	0.7	100	10	100	9	60	10	221.5241
Case 13	800	0.5	0.8	110	15	150	10	70	15	332.2862
Case 14	900	0.6	0.9	120	20	200	11	80	20	443.0483
Case 15	1000	0.7	1	130	25	250	12	90	25	553.8103
Case 16	2000	0.8	1.5	140	30	300	14	100	30	664.5724
Case 17	3000	0.9	2	150	40	350	16	250	40	886.0966
Case 18	4000	1	2.5	160	50	400	18	500	50	1107.621
Case 19	5000	2	4	175	75	500	20	1000	75	1661.431
Case 20	10000	3	8	200	100	1000	25	2000	100	2215.241

1. Flow determined by continuity. Q=VA. Thus this is only the values for 11-A-48-63. To see values of for LF 11B-42.5-45.5 and LF 11C-48-63 refer to Appendix J.

Table 4.6B – Parameter Variation

Case	10		11		12			13		14		15	
	h (ft)	V_{avg} [2] (ft/s)	h (ft)	d_s [2] (ft)	h (ft)	Q [2] (cfs)	d_s [2] (ft)	Q (cfs)	V_{avg} [2] (ft/s)	W (ft)	Q [2] (cfs)	W (ft)	V_{avg} [2] (ft/s)
Case 1	0	0	0	0	0	0	0	0	0	0	0	0	0
Case 2	0.5	7.14	0.5	0.2	0.5	11.08	0.2	1	0.02	2.5	11.45	2.5	6.91
Case 3	1	3.57	1	0.7	1	22.15	0.7	2	0.04	5	22.90	5	3.45
Case 4	2	1.78	2	1.7	2	44.30	1.7	3	0.06	10	45.78	10	1.73
Case 5	3	1.19	3	2.7	3	66.46	2.7	4	0.09	20	91.56	20	0.86
Case 6	4	0.89	4	3.7	4	88.61	3.7	5	0.11	25	114.45	25	0.69
Case 7	5	0.71	5	4.7	5	110.76	4.7	10	0.22	30	137.35	30	0.58
Case 8	6	0.59	6	5.7	6	132.91	5.7	20	0.43	35	160.24	35	0.49
Case 9	7	0.51	7	6.7	7	155.07	6.7	40	0.86	40	183.13	40	0.43
Case 10	8	0.45	8	7.7	8	177.22	7.7	60	1.29	45	206.02	45	0.38
Case 11	9	0.40	9	8.7	9	199.37	8.7	80	1.72	50	228.91	50	0.35
Case 12	10	0.36	10	9.7	10	221.52	9.7	100	2.15	60	274.69	60	0.29
Case 13	15	0.24	15	14.7	15	332.29	14.7	150	3.23	70	320.47	70	0.25
Case 14	20	0.18	20	19.7	20	443.05	19.7	200	4.30	80	366.25	80	0.22
Case 15	25	0.14	25	24.7	25	553.81	24.7	250	5.38	90	412.03	90	0.19
Case 16	30	0.12	30	29.7	30	664.57	29.7	300	6.45	100	457.82	100	0.17
Case 17	40	0.09	40	39.7	40	886.10	39.7	350	7.53	250	1144.54	250	0.07
Case 18	50	0.07	50	49.7	50	1107.62	49.7	400	8.60	500	2289.08	500	0.03
Case 19	75	0.05	75	74.7	75	1661.43	74.7	500	10.75	1000	4578.17	1000	0.02
Case 20	100	0.04	100	99.7	100	2215.24	99.7	1000	21.51	2000	9156.33	2000	0.01

2. Value summarized only for 11-A-48-63. To see values for LF 11B-42.5-45.5 and LF-11C-48-63 refer to Appendix J.

Fifteen different permutations were developed, with twenty different case studies. In each case three samples were run: LF-11A (station 48 to 63), LF-11B (station 42.5 to 45.5) and LF-11C (station 48 to 63). Total load calculations are presented in the following sections.

4.3.1 Permutation 1 – Concentration (C)

The sediment concentration in the channel was modified to see how concentration affected the total sediment load in the channel. Tables 4.4 and 4.5 summarize the initial parameters used in the program. All parameters were held constant except concentration. The concentration parameters were varied from 0 to 10,000 ppm. Table 4.7 summarizes the suspended sediment and total load within the channel at different known concentrations.

Table 4.7 – Results from Modification of Concentration

Case #	Varying Parameter	LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	C (ppm)	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day
Initial	392.48	56.73	63.26				
	298.62			23.91	28.46		
	255.37					41.85	48.28
1	0.00	Unknown Error		Unknown Error		Unknown Error	
2	10.00	1.45	3.75	0.93	1.98	1.64	3.35
3	20.00	2.89	5.77	1.87	3.28	3.28	5.57
4	40.00	5.78	9.41	3.74	5.67	6.55	9.64
5	80.00	11.56	16.14	7.47	10.14	13.11	17.25
6	100.00	14.45	19.37	9.34	12.30	16.39	20.92
7	200.00	28.91	34.84	18.68	22.75	32.77	38.69
8	300.00	43.36	49.75	28.02	32.89	49.16	55.92
9	400.00	57.82	64.34	37.37	42.87	65.54	72.84
10	500.00	72.27	78.74	46.71	52.73	81.93	89.57
11	600.00	86.73	92.99	56.05	62.52	98.31	106.16
12	700.00	101.18	107.12	65.39	72.24	114.70	122.63
13	800.00	115.64	121.16	74.73	81.91	131.09	139.01
14	900.00	130.09	135.13	84.07	91.54	147.47	155.32
15	1000.00	144.54	149.04	93.41	101.14	163.86	171.56
16	2000.00	289.09	285.95	"Z" gen neg exp		"Z" gen neg exp	
17	3000.00	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
18	4000.00	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
19	5000.00	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
20	10000.00	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	

1. LF-11A: S= 0.0008, Q = 53.54 cfs, V = 1.48 ft/sec, h = 3.1 ft, W = 15 ft, T = 72ºF, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} =0.15mm and d_s = 2.8.
2. LF 11B-42.5-45.5: S= 0.0008, Q = 26.81 cfs, V = 1.99 ft/sec, h = 5.4 ft, W = 2.5 ft, T = 72ºF, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1.
3. LF 11C-48-63: S= 0.0008, Q = 60.69 cfs, V = 1.57 ft/sec, h = 3.4 ft, W = 15 ft, T = 72ºF, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.16mm and d_s = 3.1.

The overall total load increased with an increase in measured sediment concentration. When the measured sediment concentration was set to zero, BORAMEP could not run and the program stated that “there is an unknown error”. This occurred because zero sediment concentration means there is no load to transport. When the sediment concentration is above 3000 ppm at section LF-11A-48-63, the program cannot run because there were “not enough overlapping bins”. This occurs because the sediment concentration was outside an expected range for this vertical and there were not enough overlapping size classes for a z value to be calculated. In addition, at section LF-11A-48-63 the calculated suspended sediment was slightly higher than the total load at a measured concentration of 2000 ppm. This is physically impossible and the program should have stopped running and no total load should have been calculated. At verticals LF-11B-42.5-45.5 and LF-11C-48-63 when the concentration was greater than 2000 ppm the program could not run because “the z value generates a negative exponent”. This occurred because the regression developed from the z versus ω resulted in a negative trend line.

Figure 4.4 depicts a schematic of how total load changes at each vertical when compared to measured concentration.

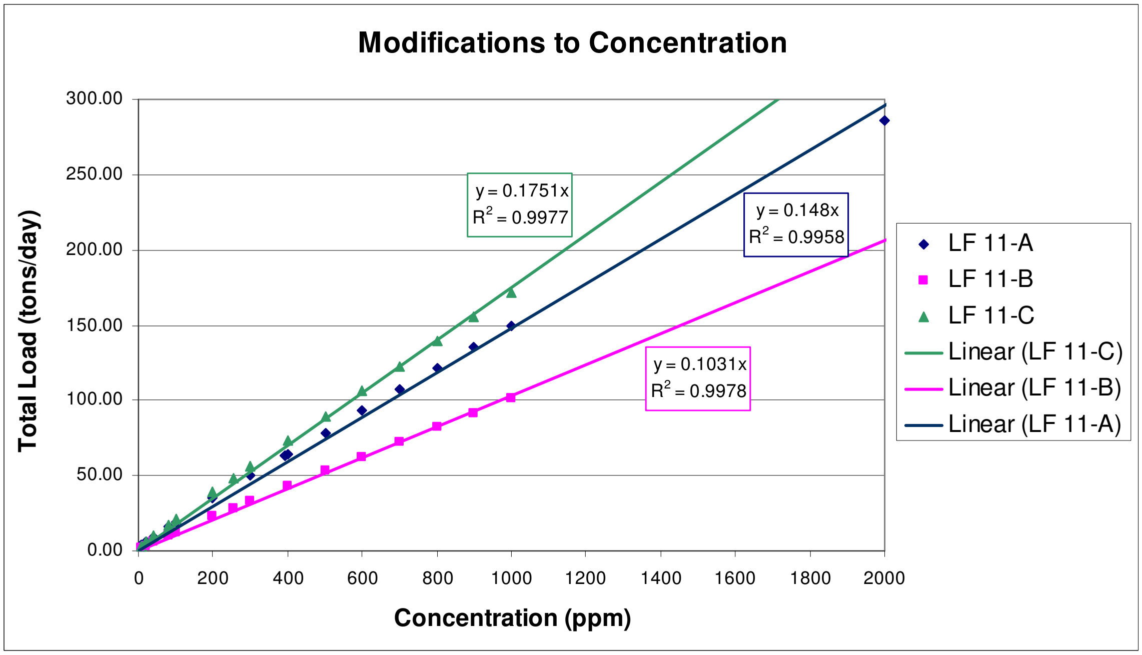

Figure 4.4 – Measured Sediment Concentration vs. Total Load

As the measured concentration in the channel increases, the suspended sediment and total sand load increase linearly. The measured sediment load and total transport load within the cross section both vary by a factor of ten. The suspended sediment load increases because it is a function of flow and measured suspended sediment concentration.

Based on the concentration analyses, checks should be placed in BORAMEP. If the suspended sediment is greater than total load, the program should state that the sediment concentration entered is outside an acceptable range. Also, if the measured sediment concentration is zero, the program should give a value of zero as the transport load.

4.3.2 Permutation 2 – Changing d_{35}

The d_{35} in the channel was modified to see how changing the size of the particles that exceeded 35% of the bed material size would affect the total load in the channel. Tables 4.4 and 4.5 summarize the initial parameters used in the program. All parameters were held constant except d_{35}. The particle diameter that allows 35% of the material to pass (d_{35}) is varied from 0.001 to 3 mm. Table 4.8 summarizes the suspended sediment and total load within the channel at different known d_{35} values.

Table 4.8 – Results from Modification of d_{35}

Case #	Varying Parameter	LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	d_{35} (mm)	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day
Initial	0.15	56.73	63.26				
	0.17			23.91	28.46		
	0.16					41.85	48.28
1	0.001	56.73	104.78	23.91	42.28	41.85	92.19
2	0.002	56.73	104.78	23.91	42.28	41.85	92.19
3	0.004	56.73	104.78	23.91	42.28	41.85	92.19
4	0.016	56.73	104.78	23.91	42.28	41.85	92.19
5	0.0625	56.73	90.65	23.91	35.53	41.85	69.64
6	0.1	56.73	74.47	23.91	31.28	41.85	56.68
7	0.12	56.73	68.82	23.91	29.91	41.85	52.95
8	0.125	56.73	67.71	23.91	29.63	41.85	52.22
9	0.2	56.73	57.87	23.91	26.86	41.85	45.35
10	0.25	Not Enough Overlap		23.91	25.81	"Z" gen neg exp	
11	0.3	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
12	0.4	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
13	0.5	Not Enough Overlap		"Z" gen neg exp		Not Enough Overlap	
14	0.6	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
15	0.7	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
16	0.8	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
17	0.9	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
18	1	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
19	2	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
20	3	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	

1. LF-11A: S= 0.0008, Q = 53.54 cfs, V = 1.48 ft/sec, h = 3.1 ft, W = 15 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, and d_s = 2.8 ft.
2. LF 11B-42.5-45.5: S= 0.0008, Q = 26.81 cfs, V = 1.99 ft/sec, h = 5.4 ft, W = 2.5 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, and d_s = 5.1ft.
3. LF 11C-48-63: S= 0.0008, Q = 60.69 cfs, V = 1.57 ft/sec, h = 3.4 ft, W = 15 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, and d_s = 3.1 ft.

As the value of d_{35} was increased, the total load in the channel decreased. At section LF 11A-48-63, when d_{35} was greater than d_{65}, the program stopped running and provided an error message, which read that there was “not enough overlapping bin”. In actuality this error does not explain what is actually occurring within the data set. This error could be better explained to the user, because it is not possible for d_{35} to be greater than d_{65}. In addition, when d_{35} was equal to d_{65} a total load was calculated. The only way d_{35} can equal d_{65} is if the sample is uniform. However, the program requires that there are a minimum of two overlapping bins. At section LF 11B-42.5-45.5 on occasions when d_{35} was greater than d_{65}, a total load was calculated. When d_{35} was greater than 0.3 mm the error messages were inconsistent. Particles between 0.3 to 0.5 mm stated that “the fitted z-values generate a negative exponent”, whereas particles greater than 0.5 stated that there are “not enough overlapping bins”. At section 11C-48-63 in all cases where d_{35} was greater than d_{65} the program stops running. Error messages varied for particles between 0.25 to 0.4 mm and particles greater than 0.4 mm, the messages stated that “the fitted z-values generate a negative exponent” and there are “not enough overlapping bins,” respectively. The errors are not consistent at each cross section. When d_{35} is greater than d_{65} the program should not calculate a total sediment load because d_{35} cannot be greater than d_{65}.

Figure 4.5 depicts total load versus the particle diameter finer than 35%.

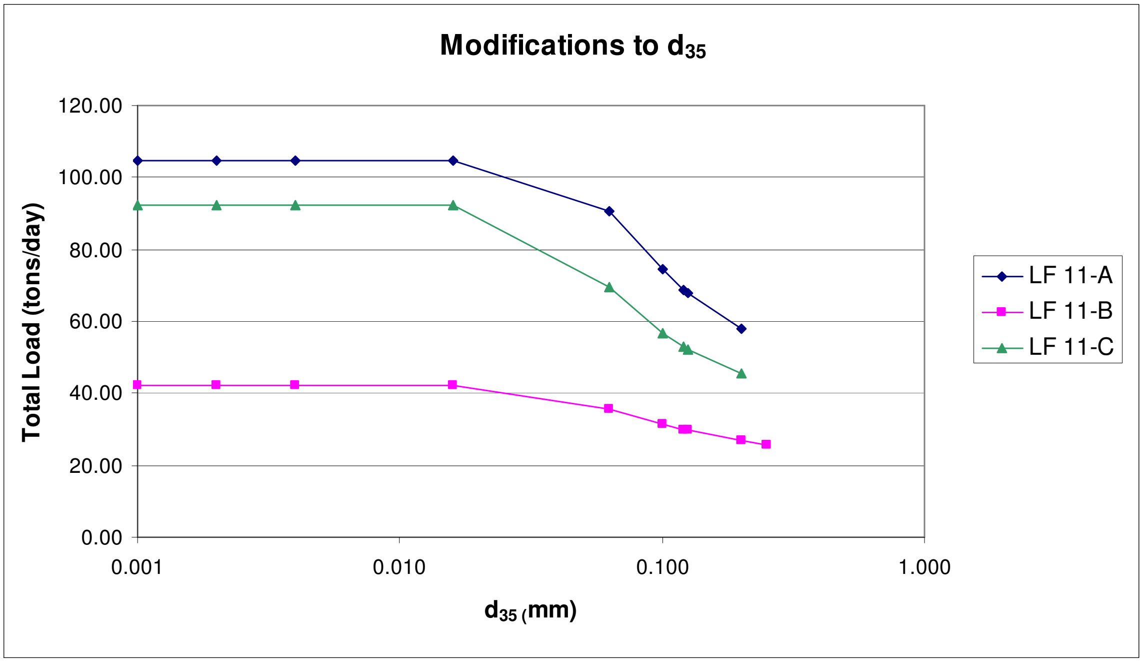

Figure 4.5 – Graph of d_{35} vs. Total Load

The graphs indicate that as particle diameter increases, the total load decreases. This occurs because smaller particles are transported in the channel more readily. However, particles between 0.001 mm and 0.016 mm result in a constant total load value. This occurred because the shear intensity of the flow acting on the median particle (d_i) in each size class (bin) was greater than the shear intensity calculated from d_{35}.

$$\psi = 1.65\left(\frac{d_{35}}{RS_f}\right) \quad or \quad 0.66\left(\frac{d_i}{RS_f}\right) \qquad \text{(Eq 4.1)}$$

Where:

Ψ= shear intensity;

R = hydraulic radius (ft);

S_f = friction slope (ft/ft);

d_i = geometric mean particle diameter of a given range (ft);

d_{35} = particle diameter that allows 35% of the material to pass (ft).

Based on the analysis, a few checks need to be incorporated to provide the user with more detailed explanation of error situations. When d_{35} is greater than or equal to d_{65} the program should state that the value of d_{35} is greater than or equal to d_{65} and no calculation should occur. This is because physically d_{35} must be smaller than d_{65}. In addition, a check should be added to verify that the inputted grain diameters match the bed material distribution. If they do not match, then the program should stop running and state that the d_{35} is outside the expected range.

4.3.3 *Permutation 3 – Changing d_{65}*

The d_{65} in the channel was modified to see how the value of the particles that exceed 65% of the bed material would affect the total load in the channel. Tables 4.4 and 4.5 summarize the initial parameters used in the program. All parameters were held constant except d_{65}. The particle diameter that allows 65% of the material to pass (d_{65}) is varied from 0.001 to 8 mm. Table 4.9 summarizes the suspended sediment and total load within the channel at different known particle sizes (d_{65}).

Table 4.9 – Results from Modification of d_{65}

Case #	Varying Parameter	LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	d_{65} (mm)	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day
Initial	0.20	56.73	63.26				
	0.22			23.91	28.46		
	0.22					41.85	48.28
1	0.001	Not Enough Overlap		Unknown Error		"Z" gen neg exp	
2	0.002	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
3	0.004	Not Enough Overlap		Unknown Error		"Z" gen neg exp	
4	0.016	Unknown Error		Unknown Error		Unknown Error	
5	0.0625	56.73	58.96	23.91	27.45	41.85	45.27
6	0.125	56.73	61.56	23.91	28.13	41.85	46.95
7	0.25	56.73	64.09	23.91	28.73	41.85	48.58
8	0.3	56.73	64.77	23.91	28.95	41.85	49.01
9	0.4	56.73	65.85	23.91	29.14	41.85	49.67
10	0.5	56.73	66.65	23.91	29.26	41.85	50.17
11	0.6	56.73	67.32	23.91	29.35	41.85	50.55
12	0.7	56.73	67.85	23.91	29.40	41.85	50.87
13	0.8	56.73	68.28	23.91	29.43	41.85	51.11
14	0.9	56.73	68.66	23.91	29.45	41.85	51.32
15	1	56.73	68.95	23.91	29.47	41.85	51.49
16	1.5	56.73	70.10	23.91	29.51	41.85	52.06
17	2	56.73	70.84	23.91	29.54	Failed to Converge	
18	2.5	56.73	72.34	23.91	29.57	41.85	53.40
19	4	56.73	73.83	23.91	29.83	41.85	54.08
20	8	56.73	75.92	23.91	29.77	41.85	54.88

1. LF 11A-48-631: S= 0.0008, Q = 53.54 cfs, V = 1.48 ft/sec, h = 3.1 ft, W = 15 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{35} = 0.15 mm and d_s = 2.8 ft.
2. LF 11B-42.5-45.5: Q = S= 0.0008, 26.81 cfs, V = 1.99 ft/sec, h = 5.4 ft, W = 2.5 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{35} = 0.17 mm and d_s = 5.1 ft.
3. LF 11C-48-63: Q = S= 0.0008, 60.69 cfs, V = 1.57 ft/sec, h = 3.4 ft, W = 15 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{35} = 0.16 mm and d_s = 3.1ft.

Based on the results, the total load was greatest at higher values of d_{65}. At section 11A-48-63 when d_{65} was between 0.001 mm and 0.004 mm there were "not enough overlapping bins", but when d_{65} was equal to 0.016 mm there was "an unknown error". At section 11B-42.5-45.5 when d_{65} equals 0.001, 0.004 and 0.016 mm there was "an unknown error", whereas at a d_{65} of 0.002 "the fitted z-value generated a negative exponent". At section 11C-48-63 when d_{65} was between 0.001 and 0.004 "the fitted z-value generated a negative exponent", whereas when d_{65} was equal to 0.016 there was "an unknown error" and the program stopped running. However, when d_{65} was equal to 2 mm the program was "unable to converge to a z-value". In addition, for all three samples when d_{65} equaled 0.0625 and 0.125 a total load was calculated even though d_{65} was less than d_{35}, which is impossible. The errors are not consistent at each cross section. When d_{35} is greater than d_{65} the program should not calculate a total load.

Figure 4.6 depicts a schematic of how total load changes at each vertical when compared to the particle diameter finer than 65%.

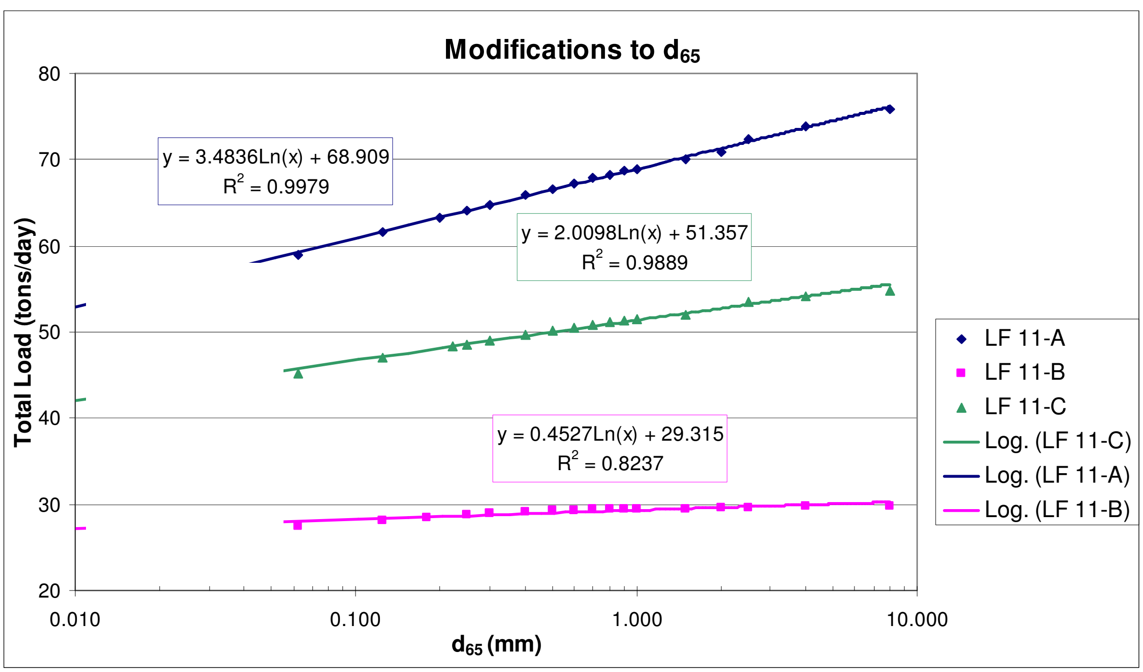

Figure 4.6 – Graph of d_{65} vs. Total Load

The graphs indicate that as particle diameter increases, the total load increased. This occurs because the value of d_{65} was used to calculation the percentage of flow sampled.

Based on the analysis a few checks need to be incorporated. When d_{35} is greater than or equal to d_{65} the program should stop running. The message should read d_{35} is greater than or equal to d_{65}, which is not physically possible because by definition d_{35} is smaller than d_{65}. If all the sediment is in one bin there are not enough overlapping bins for the total load calculation. In addition, a check should be added to verify that the inputted grain diameter value match the bed material distribution. If they do not match, then the program should stop running and state that the value of d_{65} is outside the measured bed material data.

4.3.4 Permutation 4 – Changing Water Temperature (T)

The water temperature was modified to determine how it would affect the total load in the channel. All parameters were held constant except water temperature, which ranged from 0 to 200ºF. Table 4.10 summarizes the suspended sediment and total load within the channel at different water temperatures.

Table 4.10 – Results from Modification of Water Temperature

Case #	Varying Parameter	LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	T (ºF)	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day
Initial	72	56.73	63.26	23.91	28.46	41.85	48.28
1	0	Unknown Error		Unknown Error		Unknown Error	
2	5	Unknown Error		Unknown Error		Unknown Error	
3	10	Unknown Error		23.91	27.53	41.85	45.43
4	20	56.73	62.04	23.91	28.56	41.85	48.07
5	30	56.73	62.69	23.91	28.63	41.85	48.28
6	40	56.73	62.96	23.91	28.63	41.85	48.32
7	50	56.73	63.11	23.91	28.61	41.85	48.33
8	60	56.73	63.19	23.91	28.49	41.85	48.31
9	70	56.73	63.25	23.91	28.46	41.85	48.29
10	80	56.73	63.28	23.91	28.43	41.85	48.26
11	90	56.73	63.29	23.91	28.40	41.85	48.22
12	100	56.73	63.30	23.91	28.37	41.85	48.19
13	110	56.73	63.28	23.91	28.35	41.85	48.16
14	120	56.73	63.28	23.91	28.32	41.85	48.12
15	130	56.73	63.27	23.91	28.30	41.85	48.09
16	140	56.73	63.25	23.91	28.27	41.85	48.06
17	150	56.73	63.22	23.91	28.26	41.85	48.03
18	160	56.73	63.20	23.91	28.24	41.85	48.01
19	175	56.73	63.18	23.91	28.21	41.85	47.97
20	200	56.73	63.14	23.91	28.17	41.85	47.91

1. LF 11A-48-631: S= 0.0008, Q = 53.54 cfs, V = 1.48 ft/sec, h = 3.1 ft, W = 15 ft, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} =0.15mm and d_s = 2.8.
2. LF 11B-42.5-45.5: S= 0.0008, Q = 26.81 cfs, V = 1.99 ft/sec, h = 5.4 ft, W = 2.5 ft, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1.
3. LF 11C-48-63: S= 0.0008, Q = 60.69 cfs, V = 1.57 ft/sec, h = 3.4 ft, W = 15 ft, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} – 0.16mm and d_s = 3.1

Water temperature is required by the program because it is used to determine water density and viscosity. However, in the MEP the water temperature had little to no effect on the total load because density and viscosity vary slightly with a change in water temperature. For all vertical samples, LF 11A-48-631, LF 11B-42.5-45.5 and LF 11C-48-63, when the water temperature was between 0ºF to 5ºF BORAMEP stopped running. This occurred because the program reported an unknown error. In addition, at section LF 11B-42.5-45.5 at 10ºF the program could not run due to an unknown error.

Figure 4.7 depicts a schematic of how total load changes at each vertical when compared to the water temperature.

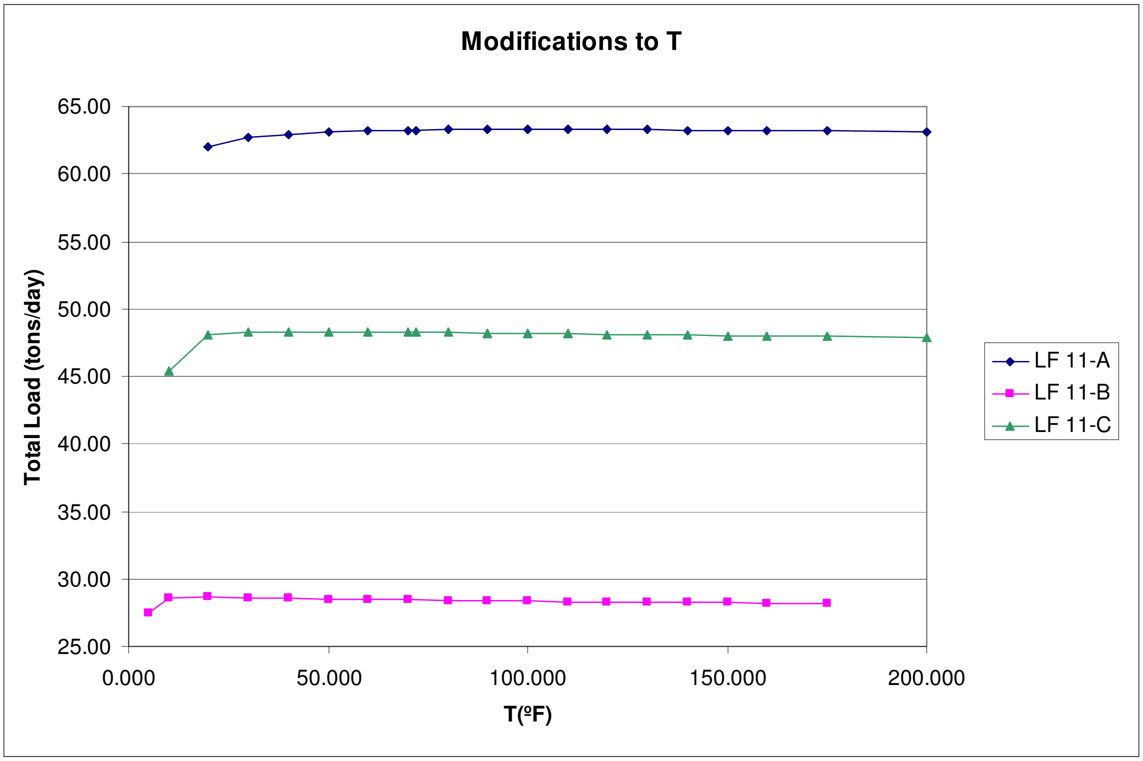

Figure 4.7 – Graph of T vs. Total Load

The graphs indicate that the water temperature has an insignificant role in determining total load.

A check should be placed in the program to verify that the water temperature parameter is reasonable. If water temperature is below freezing, sediment transport cannot be calculated by the MEP and an error should be provided indicating that there is the potential for ice flow. In addition, most rivers do not have water temperatures above 80ºF. Thus a statement should be placed in the program that states the entered water temperature is outside an acceptable range whenever the temperature is below freezing or above 80ºF.

4.3.5 Permutation 5 – Changing Flow Depth (h)

The overall channel flow depth was varied to see how it would affect the total load in the channel. All parameters were held constant except flow depth. The flow depth was varied from 0 to 100 feet. Table 4.11 summarizes the suspended sediment and total load within the channel at different depths.

Table 4.11 – Results from Modification of Flow Depth

Case #	Varying Parameter	LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	h (ft)	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day
Initial	3.1	56.73	63.26				
	5.4			23.91	28.46		
	3.4					41.85	48.28
1	0	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
2	0.5	56.73	63.26	Failed to Converge		41.85	47.22
3	1	56.73	63.24	23.91	27.36	41.85	47.67
4	2	56.73	63.25	23.91	27.89	41.85	48.04
5	3	56.73	63.26	23.91	28.17	41.85	48.22
6	4	56.73	63.27	23.91	28.35	41.85	48.35
7	5	56.73	63.27	23.91	28.41	41.85	48.44
8	6	56.73	63.27	23.91	28.52	41.85	48.32
9	7	56.73	63.00	23.91	28.61	41.85	48.38
10	8	56.73	62.99	23.91	28.69	41.85	48.43
11	9	56.73	63.00	23.91	28.75	41.85	48.47
12	10	56.73	63.00	23.91	28.81	41.85	48.50
13	15	56.73	62.99	23.91	29.02	41.85	48.62
14	20	56.73	62.97	23.91	29.16	41.85	48.70
15	25	56.73	62.95	23.91	29.26	41.85	48.75
16	30	56.73	62.93	23.91	29.35	41.85	48.78
17	40	56.73	62.89	23.91	29.47	41.85	48.83
18	50	Not Enough Overlap		23.91	29.57	41.85	48.86
19	75	Not Enough Overlap		23.91	29.73	"Z" gen neg exp	
20	100	Not Enough Overlap		23.91	29.84	"Z" gen neg exp	

1. LF 11A-48-631: S= 0.0008, Q = 53.54 cfs, V = 1.48 ft/sec, W = 15 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} =0.15mm and d_s = 2.8 ft.
2. LF 11B-42.5-45.5: S= 0.0008, Q = 26.81 cfs, V = 1.99 ft/sec, W = 2.5 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1 ft.
3. LF 11C-48-63: S= 0.0008, Q = 60.69 cfs, V = 1.57 ft/sec, W = 15 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.16mm and d_s = 3.1 ft

In this case the unmeasured depth and measured depth were kept constant. Thus sediment load did not change much with depth. At all verticals when the channel flow depth was set equal to zero, the program could not run; it stated that there were not enough overlapping bins. In actuality, this error message does not explain what is actually occurring because if there is no flow depth there is no flow. At section 11A-48-63 when the flow depth was greater than 50 feet there are not enough overlapping bins. At section 11B-42.5-45.5 when the flow depth was equal to 0.5 feet the program fails to converge to a z value. Finally at section 11C-48-63 when the flow depth is greater than 75 feet, the fitted z value generated a negative exponent and the program stopped. This inconsistency in error occurs because based on the inputted data the program is unable to calculate a sediment load.

Figure 4.8 depicts total load at each vertical compared to the channel depth.

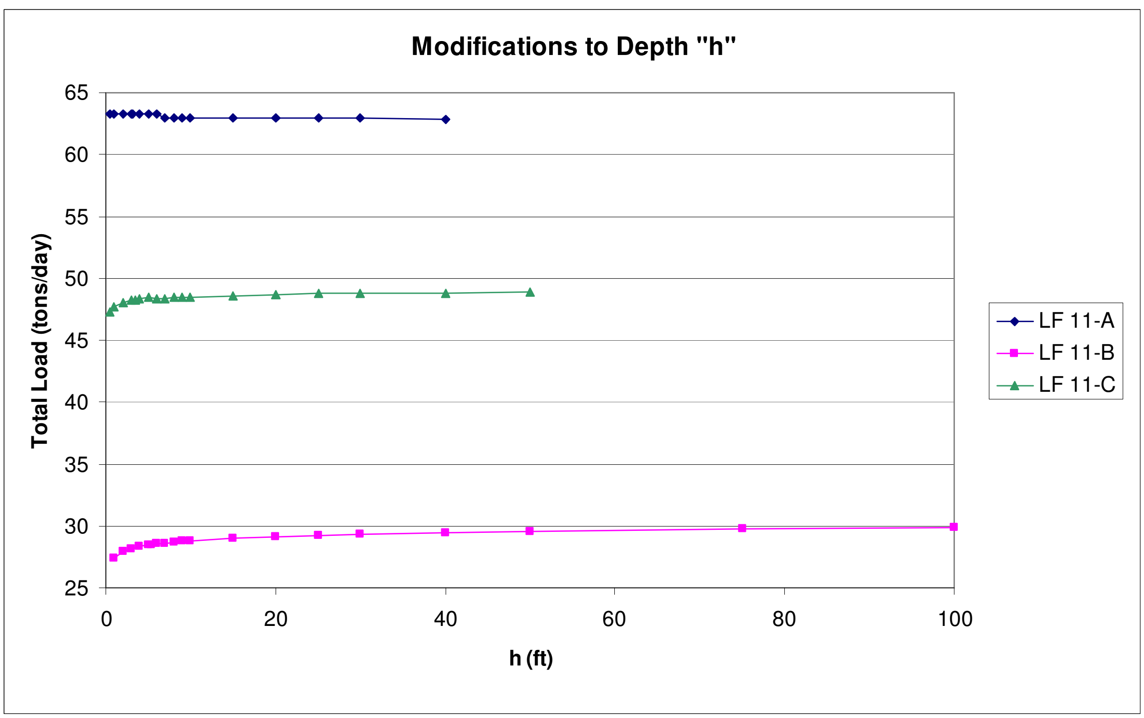

Figure 4.8 – Graph of Flow Depth vs. Total Load

The data indicate that the difference in total load between the different depths is only 2.5 tons/day. This occurs because measured depth, which is constant, is used in MEP calculation.

Checks need to be added to verify that inputted data are correct. First the unmeasured depth plus the measured depth must equal the total channel depth. If these values do not add up, then the program should state that. Next, channel continuity should be verified. If the channel area and velocity do not equate to the discharge, the program should state that continuity has been violated.

$$Q = VA \qquad \text{(Eq 4.2)}$$

Where:

Q = discharge (cfs);

A = cross sectional area (ft^2);

V = velocity (ft/s).

Finally, if the flow depth is zero the program should state that a zero value was entered for the flow depth; this means there is no channel, thus no sediment to transport.

4.3.6 Permutation 6 – Changing Discharge (Q)

The discharge in the channel was modified to see how total load would vary in the channel. All parameters were held constant except discharge. The discharge parameter was varied from 0 to 1,000 cfs. Table 4.12 summarizes the suspended sediment and total load within the channel at different discharges.

Table 4.12 – Results from Modification of Discharge

Case #	Varying Parameter	LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	Q (cfs)	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day
Initial	53.54	56.73	63.26				
	26.81			23.91	28.46		
	60.69					41.85	48.28
1	0	Unknown Error		Unknown Error		Unknown Error	
2	1	1.06	3.16	0.69	1.62	0.69	1.90
3	2	2.12	4.72	1.38	2.62	1.38	2.97
4	3	3.18	6.15	2.07	3.56	2.07	3.95
5	4	4.24	7.51	2.76	4.45	2.76	4.89
6	5	5.30	8.82	3.46	5.32	3.45	5.78
7	10	10.60	15.05	6.91	9.49	6.90	10.04
8	20	21.19	26.68	13.82	17.37	13.79	18.02
9	40	42.39	48.76	27.65	32.49	27.58	33.15
10	60	63.58	70.10	41.47	47.22	41.37	47.78
11	80	84.78	91.07	55.30	61.73	55.16	62.15
12	100	105.97	111.78	69.12	76.11	68.95	76.34
13	150	158.95	162.85	103.68	111.65	103.43	111.31
14	200	211.94	213.26	138.24	146.82	137.91	145.81
15	250	264.92	263.25	"Z" gen neg exp		172.38	179.99
16	300	317.91	312.94	"Z" gen neg exp		206.86	213.95
17	350	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
18	400	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
19	500	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
20	1000	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	

1. LF 11A-48-631: S= 0.0008, V = 1.48 ft/sec, h = 3.1 ft, W = 15 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} =0.15mm and d_s = 2.8 ft.
2. LF 11B-42.5-45.5: S= 0.0008, V = 1.99 ft/sec, h = 5.4 ft, W = 2.5 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1 ft.
3. LF 11C-48-63: S= 0.0008, V = 1.57 ft/sec, h = 3.4 ft, W = 15 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.16mm and d_s = 3.1 ft.

Based on the data presented in Table 4.11, total load increased with discharge. This is because suspended sediment is a function of discharge and measures suspended sediment concentration.

$$Q_s = Q\,C \qquad \text{(Eq 4.3)}$$

Where:

Q_s = suspended sediment load (tons/day);

Q = discharge (cfs);

C = suspended sediment concentration (mg/l).

The results indicate that the overall variation in total load was relatively small (8.5 tons/day) over the range of discharge values.

For all verticals, when the discharge was set equal to zero the program could not calculate a total sediment load. BORAMEP indicated that there was "an unknown error". At section 11A-48-63, when the discharge was greater than and equal to 350 cfs, there are "not enough overlapping bins". At section 11B-42.5-45.5 and 11C-48-63, when the discharge was greater than and equal to 250 cfs and 350 cfs, respectively, the error messages read, "the fitted z-values result in a negative exponent". This inconsistency in error does not explain what is actually causing the program to terminate. In addition, at sample 11A-48-63 when the discharge was equal to 300cfs the calculated suspended sediment load was greater than the total load, which is impossible.

Figure 4.9 depicts a schematic of how total load changes at each vertical when compared to the discharge.

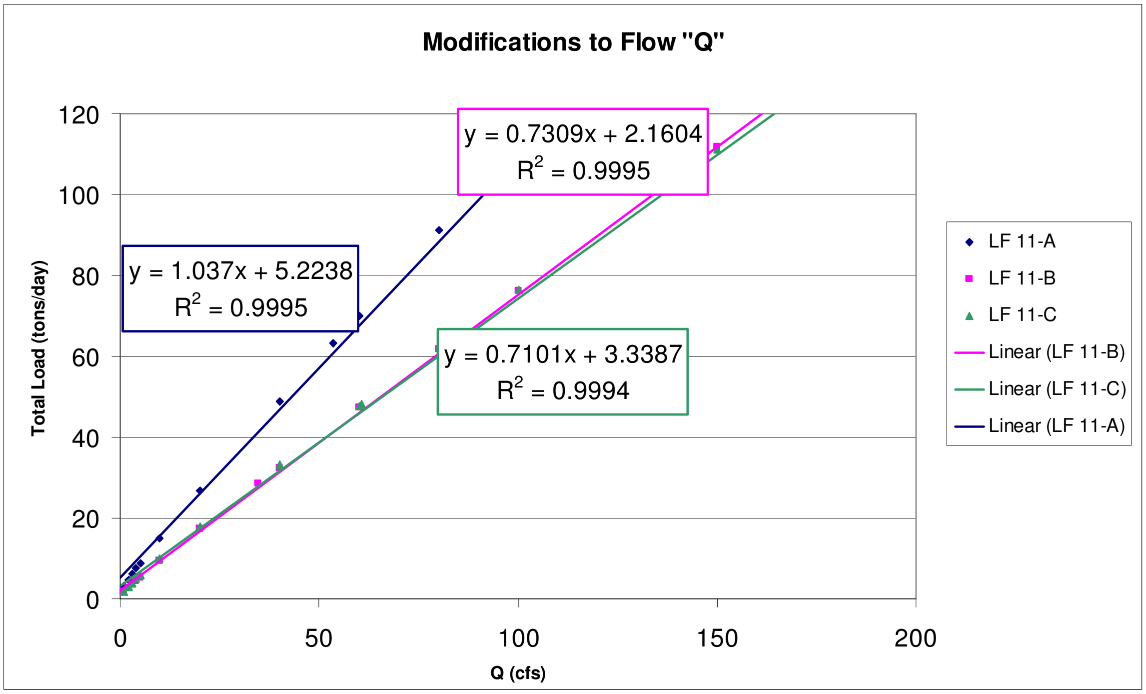

Figure 4.9 – Graph of Discharge vs. Total Load

The data indicate that total load increases linearly as discharge increased.

The discharge is a major component in determining the suspended sediment load within a channel. However, a check needs to be placed within the program to ensure channel continuity. In addition, a check needs to be added to verify that the calculated suspended sediment load is less than the total load. If this is not the case the program should state that the entered flow and/or concentration are outside an acceptable range. Finally, if the discharge is set equal to zero the total sediment transport should be calculated as zero.

4.3.7 Permutation 7 – Changing Mean Velocity (V)

The mean flow velocity in the channel was modified to see how total load in the channel changes. All parameters were held constant except mean flow velocity. The velocity was varied from 0 to 25 ft/s. Table 4.13 summarizes the suspended sediment and total load within the channel at different average velocities.

Table 4.13 – Results from Modification of Mean Velocity

Case #	Varying Parameter	LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	V (ft/s)	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day
Initial	1.48	56.73	63.26				
	1.99			23.91	28.46		
	1.57					41.85	48.28
1	0.00	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
2	0.50	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
3	1.00	Not Enough Overlap		Not Enough Overlap		"Z" gen neg exp	
4	1.50	56.73	63.98	"Z" gen neg exp		41.85	46.98
5	2.00	56.73	82.80	23.91	27.57	41.85	57.43
6	3.00	56.73	130.02	23.91	33.12	41.85	81.33
7	4.00	56.73	178.79	23.91	38.05	41.85	104.41
8	5.00	56.73	231.90	23.91	42.63	41.85	129.25
9	6.00	56.73	289.63	23.91	47.17	41.85	153.56
10	7.00	56.73	352.09	23.91	52.08	41.85	179.04
11	8.00	56.73	406.83	23.91	56.84	41.85	208.28
12	9.00	56.73	477.54	23.91	61.73	41.85	236.66
13	10.00	56.73	553.31	23.91	66.71	41.85	266.19
14	11.00	56.73	635.71	23.91	72.91	41.85	319.34
15	12.00	56.73	721.53	23.91	78.38	41.85	354.99
16	14.00	56.73	910.79	23.91	86.59	41.85	585.03
17	16.00	56.73	1033.47	23.91	98.35	41.85	481.26
18	18.00	56.73	1255.34	23.91	118.82	41.85	1720.12
19	20.00	56.73	1752.89	23.91	132.07	41.85	1970.34
20	25.00	56.73	2507.58	23.91	199.20	41.85	2680.58

1. LF 11A-48-631: S= 0.0008, Q = 53.54 cfs, h = 3.1 ft, W = 15 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} = 0.15 mm and d_s = 2.8 ft.
2. LF 11B-42.5-45.5: S= 0.0008, Q = 26.81 cfs, h = 5.4 ft, W = 2.5 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17 mm and d_s = 5.1 ft.
3. LF 11C-48-63: S= 0.0008, Q = 60.69 cfs, h = 3.4 ft, W = 15 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} – 0.16 mm and d_s = 3.1ft.

Based on the data presented in Table 4.12, total load increased with increased mean flow velocity. The average channel velocity is a significant component in calculating the percentage of flow sampled.

For all three verticals that were analyzed, when the mean velocity was set equal to zero the program could not run. The program indicated that there were “not enough overlapping bins”. At section 11A-48-63 and 11B-42.5-45.5 when velocities were less than or equal to one foot per second there were “not enough overlapping bins”. At section 11B-42.5-45.5 when velocities equaled 1.5 feet per second the error message read, “the fitted z-values result in a negative exponent”. Finally, at section 11C-48-63 when the flow was less than 0.5 feet per second there were “not enough overlapping bin” and at 1 foot per second “the fitted z-values result in a negative exponent”. This inconsistency in error does not explain the situation. Also, at low velocities sediment cannot be transported due to incipient motion.

Figure 4.10 depicts a schematic of how total load changes at each vertical when compared to the channel average velocity.

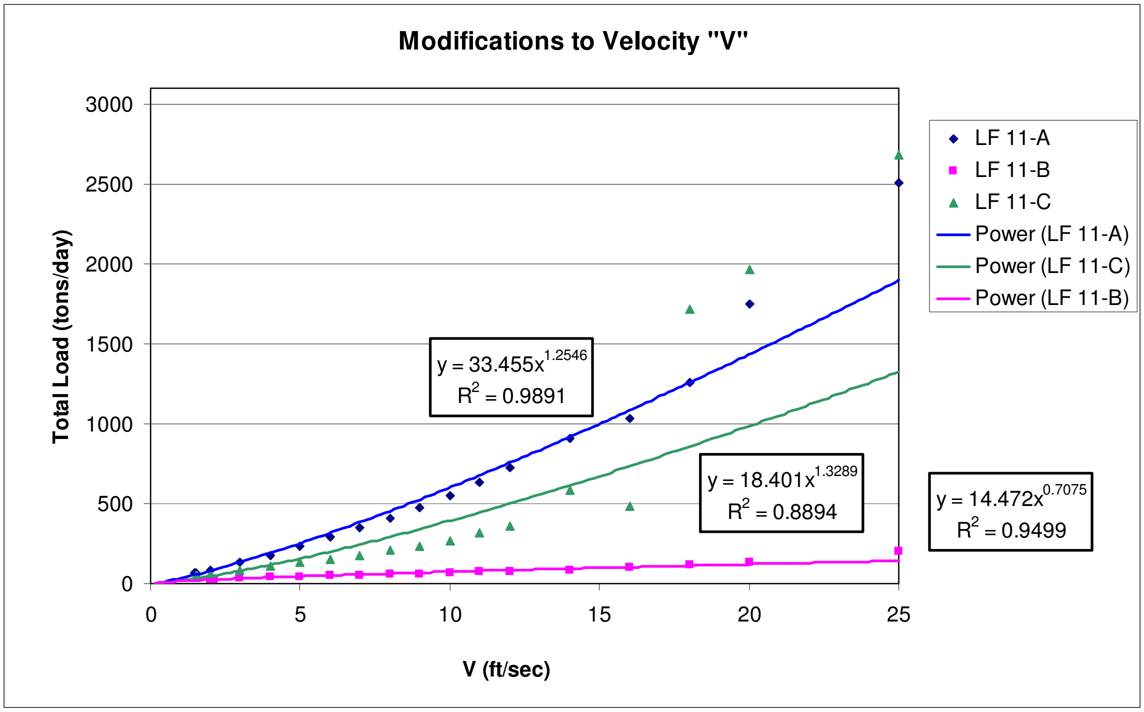

Figure 4.10 – Graph of Mean Flow Velocity vs. Total Load

The data indicate that total load increases based on a power function.

The mean flow velocity is an important component in determining the sediment load. However, a check needs to be placed within the program to ensure channel continuity. In addition, if the mean flow velocity is zero, the total load should be calculated as zero. Finally, a check should be added to verify that the shear stress on the particle is greater than the critical shear stress. If this is not the case, then the total load should be set equal to zero.

4.3.8 Permutation 8 – Changing Width

The channel width was modified to see how total load within the channel would vary. All parameters were held constant except width. The width was varied from 0 to 2,000 feet. Table 4.14 summarizes the suspended sediment and total load within the channel at different channel widths.

Table 4.14 – Results from Modification of Width

Case #	Varying Parameter	LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	W (ft)	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day
Initial	15	56.73	63.26				
	2.5			23.91	28.46		
	15					41.85	48.28
1	0	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
2	2.5	Not Enough Overlap		23.91	28.01	"Z" gen neg exp	
3	5	56.73	57.86	23.91	29.93	41.85	44.49
4	10	56.73	60.93	23.91	32.64	41.85	46.66
5	20	56.73	65.23	23.91	36.55	41.85	49.62
6	25	56.73	66.96	23.91	38.17	41.85	50.80
7	30	56.73	68.55	23.91	39.72	41.85	51.86
8	35	56.73	70.03	23.91	41.11	41.85	52.83
9	40	56.73	71.39	23.91	42.42	41.85	53.74
10	45	56.73	72.72	23.91	43.66	41.85	54.59
11	50	56.73	73.95	23.91	44.86	41.85	55.40
12	60	56.73	76.27	23.91	47.11	41.85	56.90
13	70	56.73	78.44	23.91	49.23	41.85	58.30
14	80	56.73	80.50	23.91	51.25	41.85	59.60
15	90	56.73	82.46	23.91	53.46	41.85	60.84
16	100	56.73	84.34	23.91	55.34	41.85	62.01
17	250	56.73	107.37	23.91	77.33	41.85	75.93
18	500	56.73	137.68	23.91	115.45	41.85	93.04
19	1000	Failed to Converge		23.91	198.22	41.85	120.06
20	2000	56.73	270.10	23.91	217.65	41.85	166.27

1. LF 11A-48-631: S= 0.0008, Q = 53.54 cfs, V = 1.48 ft/sec, h = 3.1 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} =0.15mm and d_s = 2.8 ft.
2. LF 11B-42.5-45.5: S= 0.0008, Q = 26.81 cfs, V = 1.99 ft/sec, h = 5.4 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1 ft.
3. LF 11C-48-63: S= 0.0008, Q = 60.69 cfs, V = 1.57 ft/sec, h = 3.4 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} – 0.16mm and d_s = 3.1 ft.

The total load increased with width because the cross sectional area of the channel increased. In all cases when the width was equal to zero, BORAMEP could not determine a total load because there were “not enough overlapping bins”. In actuality when the width equals zero there is no area for the water to flow through. In sample 11A-48-63 when the width was 2.5 feet there are “not enough overlapping bins” and at 1,000 feet the model “fails to converge to a z-value”. At section 11C-48-63 at 2.5 feet the “fitted z-value generates a negative exponent”. This inconsistency in error occurred because the inputted data caused the program to be unable to calculate a total load.

Figure 4.11 depicts a schematic of how total load changes at each vertical when compared to the channel depth.

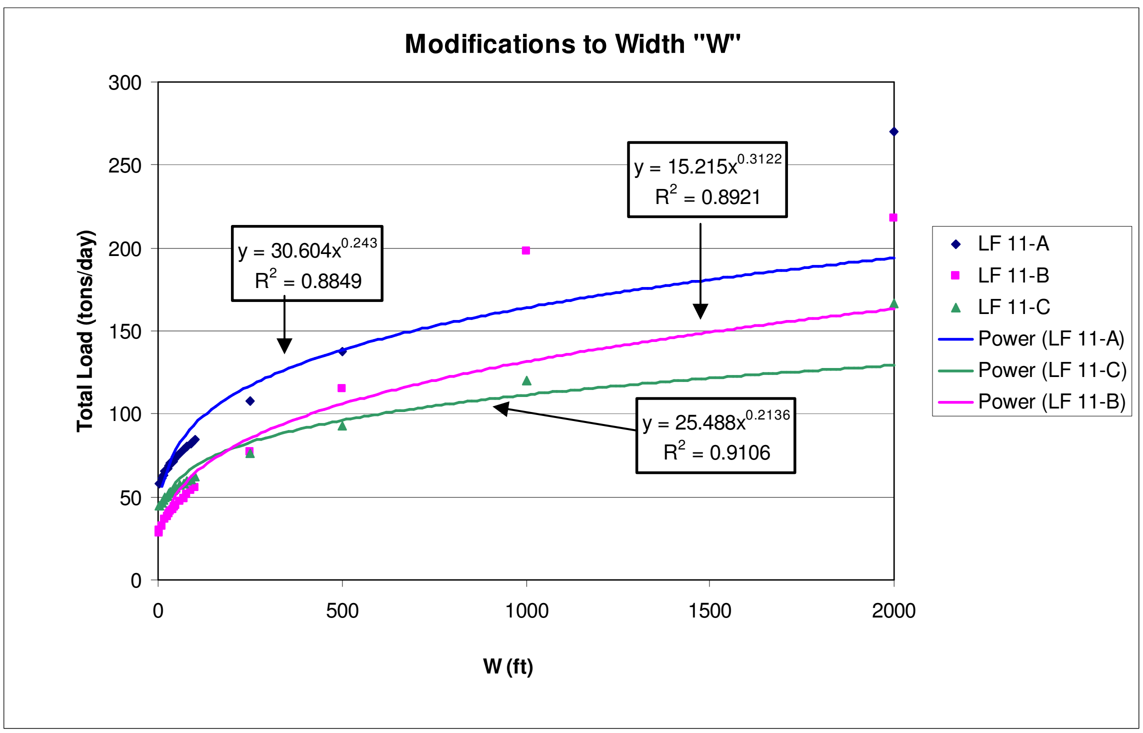

Figure 4.11 – Graph of Width vs. Total Load

The data indicate that total load increases based on a power function, and increases with increased width.

Checks need to be added to the program to verify that inputted data are correct. Channel continuity should be verified because channel width is used in cross sectional area calculations. If the channel area and mean velocity do not equate to the discharge, the program should state that continuity has been violated. Finally, if the channel width is zero the program should state that a zero value was entered for channel width. This means there is no channel thus no sediment to transport.

4.3.9 Permutation 9 – Changing Flow Depth and Discharge

The flow depth and discharge were modified to see how total sediment load changes. All parameters were held constant except flow depth and discharge. The flow depth of the channel varied from 0 to 100 feet. The discharge is determined by using the continuity equation. Table 4.15 summarizes the suspended sediment and total load within the channel at different known flow depth and discharge values.

Table 4.15 – Results from Modification of Flow Depth and Discharge

Case #	Varying Parameter		LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	h (ft)	Q[4] (cfs)	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day
Initial	3.1	53.54	56.73	63.26				
	5.4	26.81			23.91	28.46		
	3.4	60.69					41.85	48.28
1	0	0.00	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
2	0.5	11.08	11.74	17.71	2.23	3.66	Failed to Converge	
3	1	22.15	23.47	29.70	4.47	6.40	Failed to Converge	
4	2	44.30	46.95	53.44	Failed to Converge		32.48	38.24
5	3	66.46	70.42	76.90	13.41	16.75	48.72	55.40
6	4	88.61	93.90	100.14	17.88	21.79	64.96	72.38
7	5	110.76	117.37	123.24	22.35	26.71	81.20	89.25
8	6	132.91	140.85	146.22	26.82	31.67	97.44	105.62
9	7	155.07	164.32	168.34	31.29	36.59	113.68	122.26
10	8	177.22	"Z" gen neg exp		35.76	41.50	129.93	138.84
11	9	199.37	"Z" gen neg exp		40.23	46.39	"Z" gen neg exp	
12	10	221.52	"Z" gen neg exp		44.70	51.26	"Z" gen neg exp	
13	15	332.29	"Z" gen neg exp		67.05	75.47	"Z" gen neg exp	
14	20	443.05	"Z" gen neg exp		89.40	99.49	"Z" gen neg exp	
15	25	553.81	"Z" gen neg exp		"Z" gen neg exp		"Z" gen neg exp	
16	30	664.57	"Z" gen neg exp		"Z" gen neg exp		"Z" gen neg exp	
17	40	886.10	"Z" gen neg exp		"Z" gen neg exp		"Z" gen neg exp	
18	50	1107.6	"Z" gen neg exp		"Z" gen neg exp		"Z" gen neg exp	
19	75	1661.4	"Z" gen neg exp		"Z" gen neg exp		"Z" gen neg exp	
20	100	2220.0	"Z" gen neg exp		"Z" gen neg exp		Not Enough Overlap	

1. LF 11A-48-631: S= 0.0008, V = 1.48 ft/sec, W = 15 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} =0.15mm and d_s = 2.8 ft.
2. LF 11B-42.5-45.5: S= 0.0008, V = 1.99 ft/sec, W = 2.5 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1 ft.
3. LF 11C-48-63: S= 0.0008, V = 1.57 ft/sec, W = 15 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} – 0.16mm and d_s = 3.1 ft.
4. Discharge determined by continuity. Q=VA. Thus this is only the values for 11-A. To see values of discharge for LF 11B-42.5-45.5 and LF 11C-48-63 refer to Appendix J.

As the flow depth in the channel increased, total cross sectional area increased. This results in a higher discharge. More sediment is transported at a higher discharge.

During the analysis, the unmeasured depth, measured depth and mean flow velocity remained constant. In all samples when the flow depth equaled zero, the discharge was zero and the program stated that there were “not enough overlapping bins”. In actuality, zero discharge means no sediment transport. In sample 11B-42.5-45.5 when the flow depth equaled 2 feet and in sample 11C-48-63 when the depths were 0.5 and 1 foot, the program stated, “that it could not converge to a z-value”. The main error that occurred as the flow depth and discharge increase was the z value generated a negative exponent. This inconsistency in error occurs because based on the inputted data the program could not calculate total load.

Figure 4.12 depicts a schematic of how total load changes at each vertical when compared to the discharge. The graph is similar to the graph for discharge because the flow depth value was used to calculated discharge.

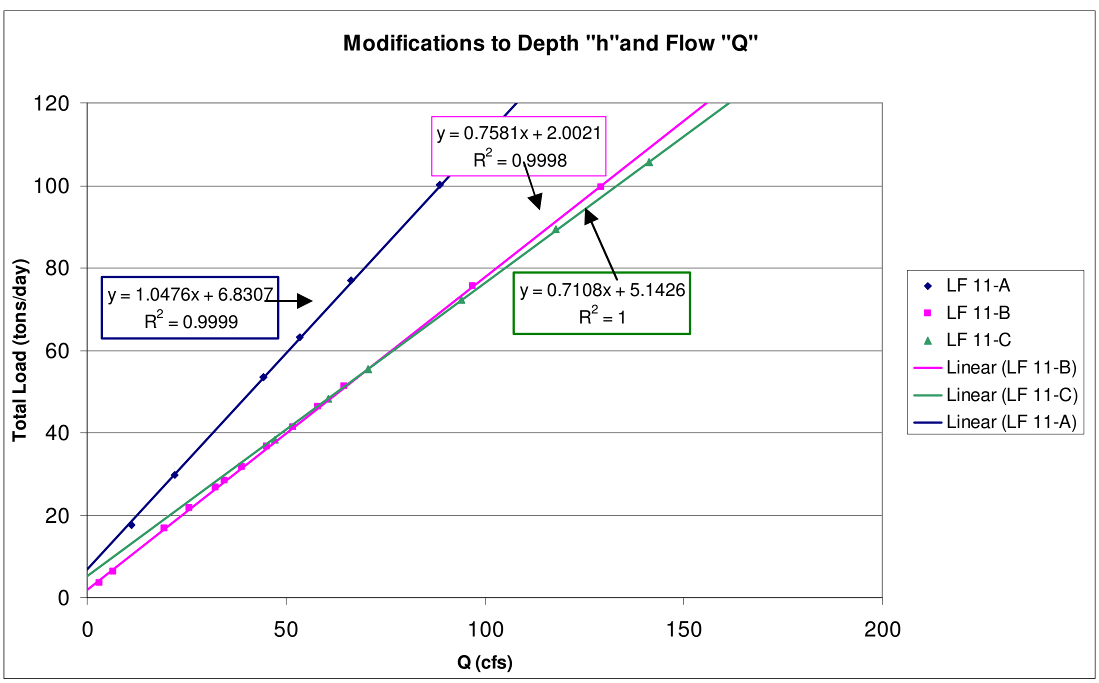

Figure 4.12 – Graph of Discharge vs. Total Load

The graph indicates that total load is linearly related to discharge.

In section 4.3.5 the flow depth of the channel was varied and had little effect on the overall sediment load because unmeasured depth plus measured depth was constant. The same is true in this scenario. However, based on continuity, discharge was varied resulting in increased suspended sediment load and thus an increase in total load.

Checks need to be added to verify that the inputted data are correct. First the unmeasured depth plus the measured depth must equal the total channel depth. If these values do not add up then the program should state that fact. Finally, if the flow depth is zero the program should state that a zero value was entered for the flow depth. This means there is no channel thus no sediment to transport.

4.3.10 Permutation 10 – Changing Flow Depth and Mean Flow Velocity

The flow depth and mean flow velocity were modified to see how total sediment load changed. All parameters were held constant except flow depth and mean flow velocity. The flow depth of the channel varied from 0 to 100 feet. The mean flow velocity was determined by using the continuity equation. Table 4.16 summarizes the suspended sediment and total load within the channel at different known flow depth and average velocity values.

Table 4.16 – Results from Modification of Flow Depth and Velocity

Case #	Varying Parameter		LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	h (ft)	V[4] (ft/s)	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day	SS Sample ton/day	Total Load tons/day
Initial	3.1	1.48	56.73	63.26				
	5.4	1.99			23.91	28.46		
	3.4	1.57					41.85	48.28
1	0	0.00	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
2	0.5	7.14	56.73	370.04	23.91	236.79	41.85	204.93
3	1	3.57	56.73	156.39	23.91	68.43	41.85	100.99
4	2	1.78	56.73	74.05	23.91	44.02	41.85	57.54
5	3	1.19	56.73	55.67	23.91	36.44	41.85	44.34
6	4	0.89	Not Enough Overlap		23.91	32.18	"Z" gen neg exp	
7	5	0.71	Not Enough Overlap		23.91	29.27	Not Enough Overlap	
8	6	0.59	Not Enough Overlap		23.91	27.18	Not Enough Overlap	
9	7	0.51	Not Enough Overlap		23.91	25.74	Not Enough Overlap	
10	8	0.45	Not Enough Overlap		"Z" gen neg exp		Not Enough Overlap	
11	9	0.40	Not Enough Overlap		"Z" gen neg exp		Not Enough Overlap	
12	10	0.36	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
13	15	0.24	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
14	20	0.18	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
15	25	0.14	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
16	30	0.12	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
17	40	0.09	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
18	50	0.07	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
19	75	0.05	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
20	100	0.04	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	

3. LF 11A-48-631: Q = 53.54 cfs, W = 15 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} =0.15mm and d_s = 2.8 ft.
4. LF 11B-42.5-45.5: Q = 26.81 cfs, W = 2.5 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1 ft.
5. LF 11C-48-63: Q = 60.69 cfs, W = 15 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.16mm and d_s = 3.1 ft.
6. Mean flow velocity determined by continuity. Q=VA. Thus this is only the values for 11-A. To see values of velocity for LF 11B-42.5-45.5 and LF 11C-48-63 refer to Appendix J.

The total load concentration decreased with an increase in channel depth. This occurred because the mean velocity in the channel decreased based on the continuity equation.

During the analysis the unmeasured depth, measured depth and discharge remained constant. At all verticals when the flow depth equaled zero, the mean flow velocity was assumed to be zero (even though the term is undefined). At this point, the program was unable to determine a total load because there were "not enough overlapping bins". Actuality, when mean flow velocity equals zero there was no flow in the channel to transport the sediment. At sample 11B-42.5-45.5 with a flow depth of 8 and 9 feet and at sample 11C-48-63 at a flow depth of 4 feet the program stopped because "a negative exponent was generated from the calculated z-value". In addition, for all verticals as the mean flow velocity decreased, the program stated that there were "not enough overlapping bins" to calculate total load. In actuality, at low velocities sediment cannot be transported.

Figure 4.13 depicts a schematic of how total load changes at each vertical when compared to the mean flow velocity.

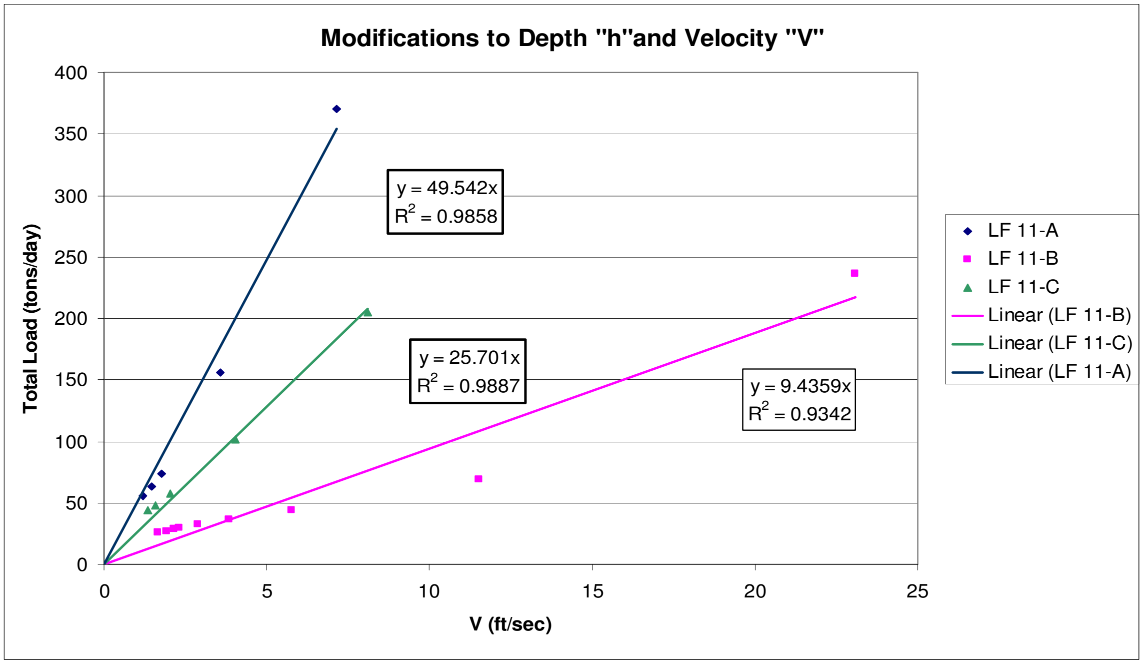

Figure 4.13 – Graph of Discharge vs. Total Load

The graph indicates that sediment concentration is linearly related to discharge. In section 4.3.5 the flow depth of the channel was varied and this had little effect on the overall sediment load because unmeasured depth plus measured depth was constant. However, based on continuity, velocity decreased with an increase in channel depth. This caused the overall total load to be reduced.

Verifications need to be placed in the program to remove the inconsistencies of the error messages. As mentioned previously the flow depth must equal the measured depth plus the unmeasured depth. In addition, a check should be placed to state that if velocity equals zero, flows should equal zero. Finally, a check should be added to verify that the shear stress of the particle is greater than the critical shear stress for the given particle. If this is not the case, then the total load should be set equal to zero.

4.3.11 Permutation 11 – Changing Flow and Sampling Depth

The flow depth and vertical sampling depth were modified to see how total sediment load was affected. The flow depth of the channel varied from 0 to 100 feet. To determine the vertical sampling depth subtract the flow depth from the unmeasured depth (Vertical Measured Depth = Flow Depth – Unmeasured Depth). The unmeasured depth was held constant at 0.3 ft. Table 4.17 summarizes the suspended sediment and total load within the channel at different known flow depth and vertical sampling depths.

Table 4.17 – Results from Modification of Flow and Sampling Depth

Case #	Varying Parameter		LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	h (ft)	d_s[4] (ft)	SS Sample tons/day	Total Load tons/day	SS Sample tons/day	Total Load tons/day	SS Sample tons/day	Total Load tons/day
	3.1	2.8	56.73	63.26				
	5.4	5.1			23.91	28.46		
Initial	3.4	3.1					41.85	48.28
1	0	0	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
2	0.5	0.2	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
3	1	0.7	56.73	80.79	Failed to Converge		41.85	61.67
4	2	1.7	56.73	67.76	23.91	32.49	41.85	52.16
5	3	2.7	56.73	63.54	23.91	30.50	41.85	49.05
6	4	3.7	56.73	61.30	23.91	29.41	41.85	47.40
7	5	4.7	56.73	59.94	23.91	28.66	41.85	46.40
8	6	5.7	56.73	59.02	23.91	28.20	41.85	45.59
9	7	6.7	56.73	58.19	23.91	27.87	41.85	45.11
10	8	7.7	56.73	57.69	23.91	27.61	41.85	44.74
11	9	8.7	56.73	57.28	23.91	27.40	41.85	44.44
12	10	9.7	56.73	56.95	23.91	27.22	41.85	44.20
13	15	14.	56.73	55.82	23.91	26.61	41.85	43.37
14	20	19.	56.73	55.13	23.91	26.23	41.85	42.87
15	25	24.	56.73	54.65	23.91	25.96	41.85	42.51
16	30	29.	56.73	54.29	23.91	25.75	41.85	42.25
17	40	39.	56.73	53.78	23.91	25.46	41.85	41.87
18	50	49.	Not Enough Overlap		23.91	25.26	"Z" gen neg exp	
19	75	74.	Not Enough Overlap		23.91	24.93	"Z" gen neg exp	
20	100	99.	Not Enough Overlap		23.91	24.74	"Z" gen neg exp	

1. LF 11A-48-631: S= 0.0008, Q = 53.54 cfs, V = 1.48 ft/sec, W = 15 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, and d_{35} =0.15mm.
2. LF 11B-42.5-45.5: S= 0.0008, Q = 26.81 cfs, V = 1.99 ft/sec, W = 2.5 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, and d_{35} = 0.17mm.
3. LF 11C-48-63: S= 0.0008, Q = 60.69 cfs, V = 1.57 ft/sec, W = 15 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, and d_{35} = 0.16mm.
4. Measured Depth was determined by subtracting the flow depth from the unmeasured depth. Thus this is only the values for 11-A. To see values of measured depth for LF 11B-42.5-45.5 and LF 11C-48-63 refer to Appendix J.

The total load concentration decreased with an increase in channel depth. This occurred because the sampling depth used by BORAMEP increased and is used to determine the percentage of flow sampled. Since the measured sediment concentration is held constant with changing depth the total load will decrease with an increase in flow depth.

At all verticals when the flow depth was between 0 and 0.5 feet there were “not enough overlapping bins” and the total load could not be determined. At section 11A-48-63 when the flow depth was equal to and greater than 50 feet there are “not enough overlapping bins”. At section 11B-42.5-45.5 when the flow depth was 1 foot the program “fails to converge to a z value”; however, the model works for larger depths. Finally, at section 11C-48-63 when the flow depth was equal to and greater than 50 feet the fitted z value generates a negative exponent. Both verticals sampled at 11A-48-63 and 11C-48-63 are located in the riprap sections of the cross section. Thus errors for these two conditions occurred at the same depth. However, at 11A-48-63 the error message read, “not enough overlapping bins” and at 11C-48-63 the “fitted z value generated a negative exponent”.

Figure 4.14 depicts a schematic of how total load changes at each vertical when compared to the depth.

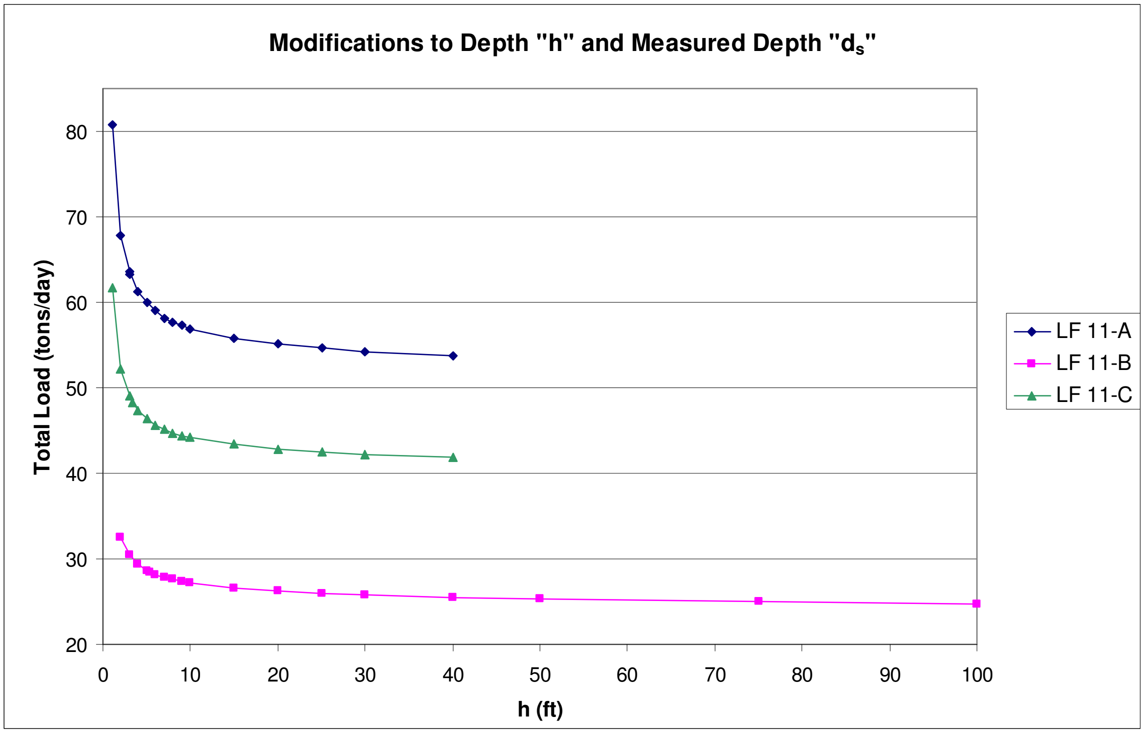

Figure 4.14 – Graph of Flow Depth vs. Total Load

At all verticals the total load follows a similar trend. Initially the sediment load decreases rapidly until a flow depth of 10 feet and then the load is relatively constant. This is because the measured sediment concentration and flow rate were constant.

Checks need to be added to verify that the inputted data are correct. Channel continuity should be verified because flow depth is used in cross sectional area calculations. If the channel area and velocity do not equate to the discharge the program should state that continuity has been violated. Finally, if the flow depth is zero the program should state that a zero value has been entered for channel depth; this means there is no channel, thus no sediment to transport.

4.3.12 Permutation 12–Changing Discharge and Flow and Sampling Depth

The channel depth, vertical sampling depth and flow were modified to see how total sediment load was affected. The depth of the channel varied from 0 to 100 feet. To determine the vertical sampling depth, the flow depth is subtracted from the unmeasured depth, which is held constant at 0.3 ft. The discharge is determined based on the continuity equation by holding the mean flow velocity constant. Table 4.18 summarizes the suspended sediment and total load within the channel at different flow depths, vertical sampling depths and discharge.

Table 4.18 – Results from Modification of Depth, Discharge and Sampling Distance

Case #	**Varying Parameter**			**LF 11-A-48-63[1]**		**LF 11-B-42.5-45.5[2]**		**LF 11-C-48-63[3]**	
	h (ft)	**Q[4] (cfs)**	**d_s[4] (ft)**	**SS Sample tons/day**	**Total Load tons/day**	**SS Sample ton/day**	**Total Load tons/day**	**SS Sample tons/day**	**Total Load tons/day**
Initial	3.1	53.54	2.8	56.73	63.26				
	5.4	26.81				23.91	28.46		
	3.4	60.69						41.85	48.28
1	0	0.00	0	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
2	0.5	11.08	0.2	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
3	1	22.15	0.7	23.47	40.87	4.47	10.91	Failed to Converge	
4	2	44.30	1.7	46.95	57.49	Failed to Converge		32.48	41.80
5	3	66.46	2.7	70.42	77.23	13.41	18.40	48.72	56.30
6	4	88.61	3.7	93.90	97.49	17.88	22.68	64.96	71.15
7	5	110.76	4.7	117.37	118.12	22.35	26.95	81.20	86.24
8	6	132.91	5.7	140.85	138.97	26.82	31.33	97.44	101.19
9	7	155.07	6.7	164.32	159.52	31.29	35.73	113.68	116.51
10	8	177.22	7.7	Not Enough Overlap		35.76	40.14	"Z" gen neg exp	
11	9	199.37	8.7	Not Enough Overlap		40.23	44.55	"Z" gen neg exp	
12	10	221.52	9.7	Not Enough Overlap		44.70	48.97	"Z" gen neg exp	
13	15	332.29	14.7	Not Enough Overlap		67.05	71.05	"Z" gen neg exp	
14	20	443.05	19.7	Not Enough Overlap		89.40	93.08	"Z" gen neg exp	
15	25	553.81	24.7	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
16	30	664.57	29.7	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
17	40	886.10	39.7	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
18	50	1107.6	49.7	Not Enough Overlap		"Z" gen neg exp		"Z" gen neg exp	
19	75	1661.4	74.7	Not Enough Overlap		"Z" gen neg exp		Not Enough Overlap	
20	100	2220.0	99.7	Not Enough Overlap		"Z" gen neg exp		Not Enough Overlap	

1. LF 11A-48-631: S= 0.0008, Q = 53.54 cfs, V = 1.48 ft/sec, h = 3.1 ft, W = 15 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} =0.15mm and d_s = 2.8.
2. LF 11B-42.5-45.5: S= 0.0008, Q = 26.81 cfs, V = 1.99 ft/sec, h = 5.4 ft, W = 2.5 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1.
3. LF 11C-48-63: S= 0.0008, Q = 60.69 cfs, V = 1.57 ft/sec, h = 3.4 ft, W = 15 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} – 0.16mm and d_s = 3.1.
4. Measured depth was determined by subtracting the flow depth from the unmeasured depth. Discharge was determined based on the continuity equation. Thus this is only the values for 11-A. To see values of measured depth and discharge for LF 11B-42.5-45.5 and LF 11C-48-63 refer to Appendix J.

The total load increased with increased flow depth and discharge. This occurred because as flow depth increased, the total cross sectional area increased. This results in a higher flow rate, which can transport more sediment. The total sediment was less than permutation 10, where only the discharge and flow depth were altered (Section 4.3.10) because the vertical sampling depth remained constant for that instance.

At all verticals when flow depth was equal to 0 and 0.5 feet BORAMEP could not calculate sediment load because there were "not enough overlapping bins". This is because there is minimal discharge in the channel to transport the sediment. At section 11A-48-63 when the flow depth was greater than or equal to 8 feet the program could not run because the "fitted z value generated a negative exponent". At section 11B-42.5-45.5 when the flow depth was equal to 2 feet and the discharge was 12.93 cfs the program "failed to converge to a z value". In addition, at section 11B-42.5-45.5 when the flow depth was greater than 25 feet "the fitted z-values generated a negative exponent". Finally, at section 11C-48-63 when the flow depth was 1 foot the program "failed to converge to a z value"; at depths between 8 to 50 feet "the fitted z-value generates a negative exponent"; and at flow depth greater than 75 feet there were "not enough overlapping bins".

Figure 4.15 depicts a schematic of how total load changes at each vertical when compared to the discharge.

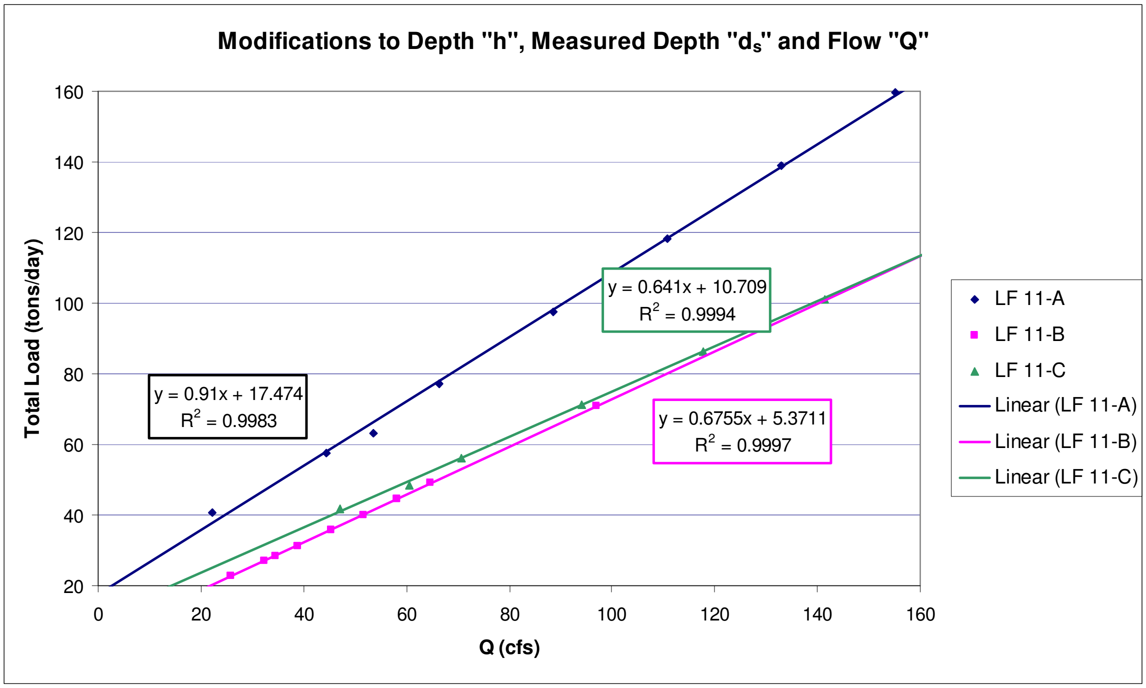

Figure 4.15 – Graph of Discharge versus Total Load

The graphs show that as the flow depth and discharge increase the total load increases linearly. The total load increased because it is governed by the discharge and vertical sampling depth.

Verifications are necessary to make sure that the inputted parameters are within an acceptable range. In order to transport sediment, the shear stress of the particle needs to be greater than the critical shear stress for the given particle. If this is not the case then the total load should be set equal to zero. The total load cannot be determined at high sediment depths and discharges because the program is unable to converge to a total load.

4.3.13 Permutation 13 – Changing Discharge and Mean Flow Velocity

The discharge and mean flow velocity were modified to see how total sediment load would be affected. The discharge within the channel was varied between 0 to 1000 cfs. The mean flow velocity in the channel was determined by the continuity equation by holding cross sectional area constant. Table 4.19 summarizes the suspended sediment and total load within the channel at different discharges and velocities.

Table 4.19 – Results from Modification of Discharge and Mean Flow Velocity

Case #	Varying Parameter		LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	Q (cfs)	V[4] (ft/s)	SS Sample tons/day	Total Load tons/day	SS Sample tons/day	Total Load tons/day	SS Sample tons/day	Total Load tons/day
Initial	53.54	1.48	56.73	63.26				
	26.81	1.99			23.91	28.46		
	60.69	1.57					41.85	48.28
1	0	0.00	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
2	1	0.02	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
3	2	0.04	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
4	3	0.06	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
5	4	0.09	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
6	5	0.11	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
7	10	0.22	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
8	20	0.43	Not Enough Overlap		"Z" gen neg exp		Not Enough Overlap	
9	40	0.86	Not Enough Overlap		27.65	34.41	Not Enough Overlap	
10	60	1.29	63.58	64.61	41.47	57.89	"Z" gen neg exp	
11	80	1.72	84.78	101.07	55.30	82.29	55.16	62.11
12	100	2.15	105.97	146.35	69.12	107.85	68.95	87.00
13	150	3.23	158.95	277.84	103.68	176.30	103.43	159.48
14	200	4.30	211.94	421.65	138.24	250.85	137.91	237.13
15	250	5.38	264.92	577.84	172.80	331.07	172.38	318.62
16	300	6.45	317.91	746.11	207.36	416.66	206.86	404.44
17	350	7.53	370.89	926.01	241.92	507.29	241.34	494.37
18	400	8.60	423.88	1117.49	276.48	606.41	275.82	588.72
19	500	10.75	529.85	1534.02	345.60	813.61	344.77	789.64
20	1000	21.51	1059.70	4238.85	691.20	2072.61	689.54	2025.71

1. LF 11A-48-631: S= 0.0008, h = 3.1 ft, W = 15 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} = 0.15mm and d_s = 2.8 ft
2. LF 11B-42.5-45.5: S= 0.0008, h = 5.4 ft, W = 2.5 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1ft
3. LF 11C-48-63: S= 0.0008, h = 3.4 ft, W = 15 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.16mm and d_s = 3.1ft
4. Mean flow velocity was determined based on the continuity equation. Thus this is only the values for 11-A. To see values of measured depth and discharge for LF 11B-42.5-45.5 and LF 11C-48-63 refer to Appendix J.

These two parameters are major components in determining the transport load in a channel. As the discharge increased the mean velocity also increased in the channel due to continuity. Thus the total load increased significantly with discharge and mean flow velocity.

In all cases when the average velocity in the channel was small the program was unable to calculate a total load. This occurs because zero velocity means zero sediment transport. At section 11A-48-63 when the mean flow velocity was between 0 to 0.86 ft/sec there were “not enough overlapping bins”. At section 11B-42.5-45.5 when the mean flow velocity was between 0 to 0.62 ft/sec there are “not enough overlapping bins”. At section 11C-48-63 when the mean flow velocity was between 0 to 0.78 ft/sec there are “not enough overlapping bins”. At section 11B-42.5-45.5 at a discharge of 20 cfs and at section 11C-48-63 with a discharge of 60 cfs “the fitted z-values generate a negative exponent”.

Figure 4.16 depicts a schematic of how total load changes at each vertical when compared to the discharge and mean flow velocity.

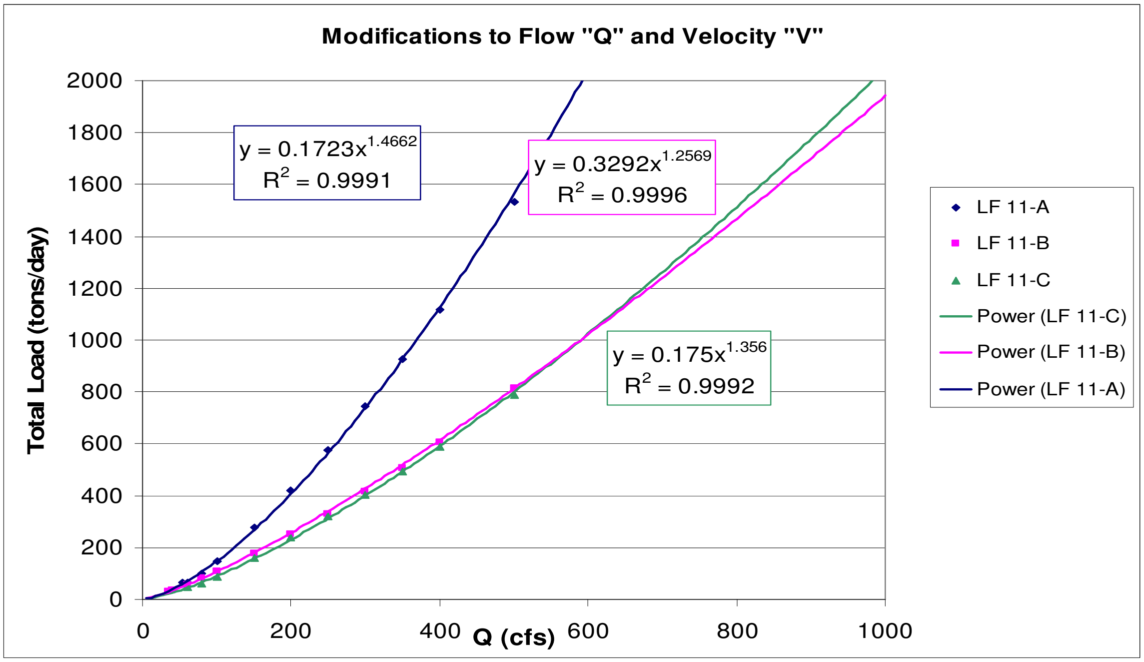

Figure 4.16 – Graph of Discharge versus Total Load

The graph shows that total load increases by a power function.

Once average velocity reached a threshold, the program could no longer continue running. A check needs to be added to determine the shear stress of the particle versus the critical shear stress for the given particle. If the shear stress is not greater than the critical shear stress, then the total load should be set equal to zero.

4.3.14 Permutation 14 – Changing Width and Discharge

The channel width and discharge were modified to see how total sediment load was affected. The channel width was varied from 0 to 2,000 ft. The discharge was determined by the continuity equation by holding mean flow velocity constant. Table 4.20 summarizes the suspended sediment and total load within the channel at different widths and discharge.

Table 4.20 – Results from Modification of Width and Discharge

Case #	Varying Parameter		LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	W (ft)	Q[4] (cfs)	SS Sample tons/day	Total Load tons/day	SS Sample tons/day	Total Load tons/day	SS Sample tons/day	Total Load tons/day
	15	53.535	56.73	63.26				
	2.5	26.81			23.91	28.46		
Initial	5	60.69					41.85	48.28
1	0	0.00	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
2	2.5	11.45	12.13	13.21	20.11	23.92	9.20	10.37
3	5	22.89	24.26	26.41	40.23	47.83	18.41	20.74
4	10	45.78	48.51	52.83	80.46	95.67	36.81	41.47
5	20	91.56	97.03	105.65	160.92	191.33	73.62	82.94
6	25	114.45	121.29	132.07	201.14	239.17	92.03	103.68
7	30	137.34	145.54	158.48	241.37	287.00	110.44	124.41
8	35	160.24	169.80	184.89	281.60	334.83	128.84	145.15
9	40	183.13	194.06	211.31	321.83	382.67	147.25	165.88
10	45	206.02	218.32	237.72	362.06	430.50	165.65	186.62
11	50	228.91	242.57	264.13	402.29	478.33	184.06	207.36
12	60	274.69	291.09	316.96	482.75	574.00	220.87	248.83
13	70	320.47	339.60	369.79	563.20	669.67	257.68	290.30
14	80	366.25	388.12	422.61	643.66	765.33	294.50	331.77
15	90	412.03	436.63	475.44	724.12	861.00	331.31	373.24
16	100	457.82	485.15	528.27	804.58	956.67	368.12	414.71
17	250	1144.54	1212.87	1320.67	2011.44	2391.67	920.30	1036.78
18	500	2289.08	2425.73	2641.34	4022.88	4783.33	1840.61	2073.55
19	1000	4578.17	4851.46	5282.67	8045.76	9566.66	3681.21	4147.11
20	2000	9176.00	9702.93	10565.3 5	16091.5 2	19133.3 3	7362.42	8294.21

1. LF 11A-48-631: S= 0.0008, V = 1.48 ft/sec, h = 3.1 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} =0.15mm and d_s = 2.8 ft.
2. LF 11B-42.5-45.5: S= 0.0008, V = 1.99 ft/sec, h = 5.4 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1 ft.
3. LF 11C-48-63: S= 0.0008, V = 1.57 ft/sec, h = 3.4 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} – 0.16mm and d_s = 3.1 ft.
4. Discharge was determined based on the continuity equation. Thus this is only the values for 11-A. To see values of measured discharge for LF 11B-42.5-45.5 and LF 11C-48-63 refer to Appendix J.

Total sediment load increased because as discharge increased suspended sediment load increased. The only error occurred when the width and discharge were equal to zero. BORAMEP stopped running because there was no discharge for the sediment to be transported.

Figure 4.17 depicts a schematic of how total load changes at each vertical when compared to the discharge and mean flow velocity.

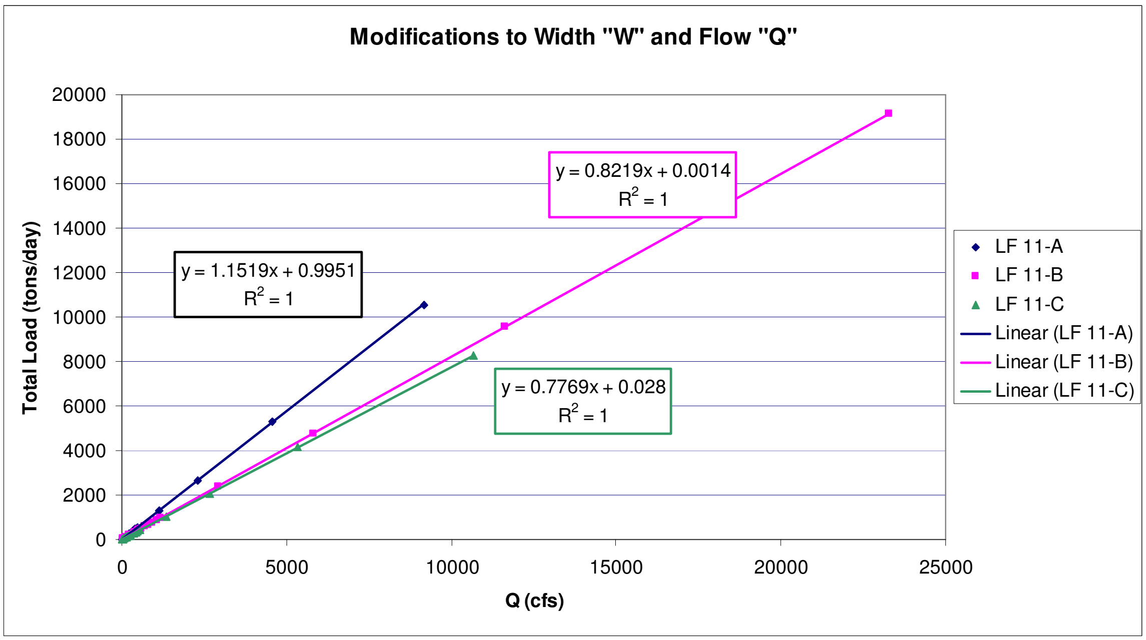

Figure 4.17 – Graph of Discharge versus Total Load

The graph indicates that the total load increases linearly with an increase in channel width and flow.

A check needs to be placed in BORAMEP for one condition. If the channel width is zero, the program should state that a zero value was entered for channel width. This means there is no channel, thus no sediment to transport.

4.3.15 Permutation 15 – Changing Width and Mean Flow Velocity

The channel width and mean flow velocity were modified to see how total sediment load was affected. The channel width was varied from 0 to 2,000 ft. The mean flow velocity was determined from the continuity equation by holding discharge constant (Q=VA). Table 4.21 summarizes the suspended sediment and total load within the channel at different widths and velocities.

Table 4.21 – Results from Modification of Width and Mean Flow Velocity

Case #	Varying Parameter		LF 11-A-48-63[1]		LF 11-B-42.5-45.5[2]		LF 11-C-48-63[3]	
	W (ft)	V[4] (ft/s)	SS Sample tons/day	Total Load tons/day	SS Sample tons/day	Total Load tons/day	SS Sample tons/day	Total Load tons/day
	15	1.48	56.73	63.26				
	2.5	1.99			23.91	28.46		
Initial	15	1.57					41.85	48.28
1	0	0.00	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
2	2.5	6.91	56.73	136.83	23.91	30.13	41.85	86.76
3	5	3.45	56.73	102.55	"Z" gen neg exp		41.85	69.62
4	10	1.73	56.73	67.82	Not Enough Overlap		41.85	50.25
5	20	0.86	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
6	25	0.69	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
7	30	0.58	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
8	35	0.49	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
9	40	0.43	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
10	45	0.38	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
11	50	0.35	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
12	60	0.29	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
13	70	0.25	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
14	80	0.22	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
15	90	0.19	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
16	100	0.17	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
17	250	0.07	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
18	500	0.03	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
19	1000	0.02	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	
20	2000	0.01	Not Enough Overlap		Not Enough Overlap		Not Enough Overlap	

1. LF 11A-48-631: S= 0.0008, Q = 53.54 cfs, h = 3.1 ft, T = 72ºF, C = 392.48 ppm, d_n = 0.3 ft, d_{65} = 0.20 mm, d_{35} =0.15mm and d_s = 2.8 ft.
2. LF 11B-42.5-45.5: S= 0.0008, Q = 26.81 cfs, h = 5.4 ft, T = 72ºF, C = 298.62 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.17mm and d_s = 5.1 ft.
3. LF 11C-48-63: S= 0.0008, Q = 60.69 cfs, h = 3.4 ft, T = 72ºF, C = 255.38 ppm, d_n = 0.3 ft, d_{65} = 0.22 mm, d_{35} = 0.16mm and d_s = 3.1 ft.
4. Mean flow velocity was determined based on the continuity equation. Thus this is only the values for 11-A. To see values of measured velocity for LF 11B-42.5-45.5 and LF 11C-48-63 refer to Appendix J.

Total sediment load decreased because as width increased velocity decreased. At lower velocity less sediment was transported. At all verticals when the mean flow velocity and width equaled zero there are “not enough overlapping bins” for the program to calculate a sediment load. In actuality there was no movement of water to allow for the transport of sediment. At section 11A-48-63 and 11C-48-63 when the width was greater than and equal to 20 feet there are “not enough overlapping bins”. At section 11B-42.5-45.5 when the width equaled 5 feet an error stated that “the fitted z-value generates a negative exponent”; however, when widths were greater than and equal to 10 feet the error stated that there were “not enough overlapping bins”.

Figure 4.18 depicts a schematic of how total load changes at each vertical when compared to the width and mean flow velocity.

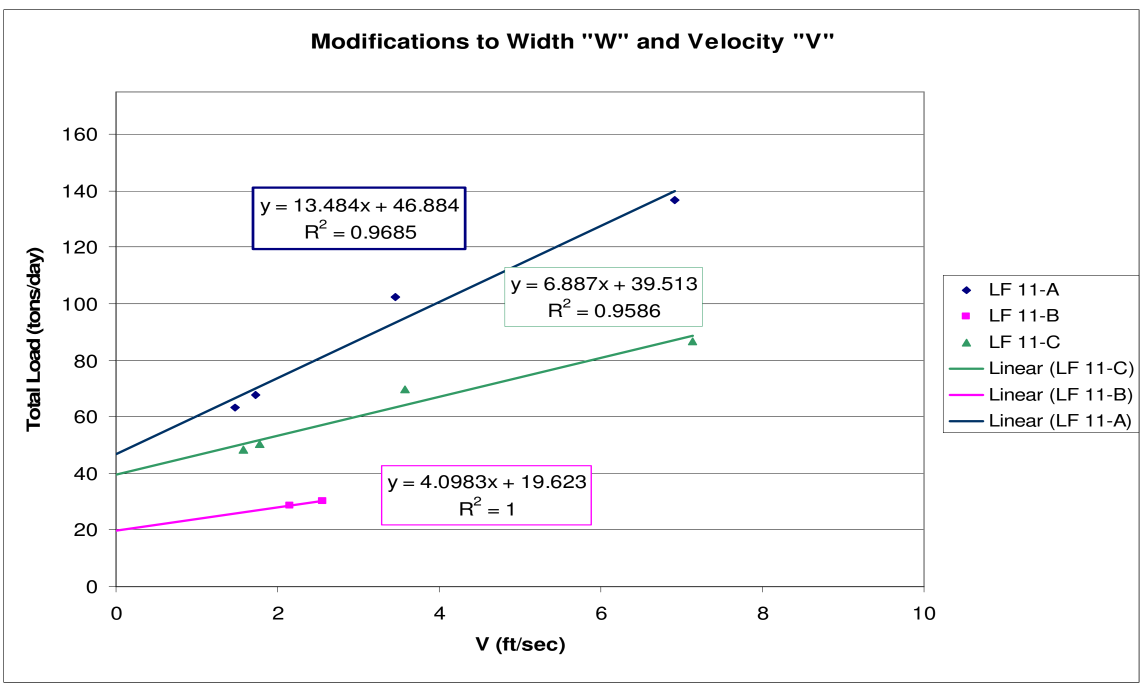

Figure 4.18 – Graph of Mean Flow Velocity versus Total Load

The graph shows that the sediment load increased linearly with increased mean flow velocity.

Once velocity reached a threshold, the program could no longer continue running. A check needs to be added to determine the shear stress of the particle versus the critical shear stress for the given particle. If the shear stress is not greater than the critical shear stress, then the total load should be set equal to zero.

4.4 Summary

The LFCC was used as the basis for testing the variability of BORAMEP. Based on the analyses presented in Chapter 4, following is a summary of the results.

Cross Section LF-11 was determined to be the most suitable section to test. Based on the matrix developed (Table 4.2), verticals LF-11A-48-63, LF-11B-42.5-45.5 and LF-11C-48-63 were chosen to be further analyzed because they resulted in no errors at any percent of overlap. On average, by varying the percent of overlap the total load calculated at each vertical only varies by 9%. Thus a looping program should be added to calculate the percent overlap. The program produced minimal errors when the percent overlap was between 1 to 2%. All further analyses were conducted at an overlap of 1.3% because this was within an optimal zone where total load was calculated for almost all the verticals.

The error messages “not enough overlapping bins” and “a negative exponent” are better explained by the graphs of the verticals presented in Appendix H. The graphs show that overlap does exist, but there needs to be at least two or more size classes with overlap for a sediment load to be calculated. When the overlap of zero was inputted, the regression equation resulted in a negative trend line. This occurs because the measured suspended sediment load is significantly greater than the bed load, resulting in a lower z value than expected. This could be improved by requiring a minimum of three overlapping size classes or bins.

The following parameters and combinations were varied to determine how total sediment load changed based on the variability of each factor: depth, width, discharge, mean flow velocity, concentration, vertical sampling depth, d_{35}, d_{65} and water temperature. It is determined that particle size, channel geometry, and flow regime have significant impacts on total load.

Based on this analysis, the error messages provided by the program did not always indicate what was actually causing the program to stop running. Thus Table 4.22 summarizes checks and error messages suggested for BORAMEP. These checks and error messages will aid the program user.

Table 4.22 – Additional Checks and Error Messages

Checks	Error Message	Calculate Total Load
The continuity equation should be verified.	Based on the entered hydraulic information, continuity is violated.	
The depth, width, discharge or velocity is zero.		Total Load = 0
The measured depth plus unmeasured depth must equal the total depth.	There is an inconsistency in the data entered for channel total depth, measured depth and unmeasured depth.	
The suspended sediment load cannot be greater than the total sediment load.	The entered sediment concentration is outside an acceptable range.	
If the measured sediment concentration equals zero then the total load should be zero.		Total Load = 0
The value of d_{35} must be less than d_{65}.	Value of d_{35} cannot be larger than d_{65}.	
The value of d_{35} must be within the range of entered bed material particle distribution	The value entered for d_{35} does not match entered bed material particle distribution.	
The value of d_{65} must be within the range of entered bed material particle distribution	The value entered for d_{65} does not match entered bed material particle distribution.	
Using the known particle diameter (d35, d50 and d65) the shear and critical shear stress should be determined. If the critical shear stress is greater than the shear stress then there is not sediment transport.		Total Load = 0
The entered channel water temperature needs to be within an acceptable range of 32 to 80ºF.	Total load could not be determined because the entered water temperature is outside the acceptable range (32 to 80ºF).	

Chapter 5: Summary and Conclusion

The United States Bureau of Reclamation has developed and uses the Automated Modified Einstein Method (BORAMEP) to estimate total sediment load in rivers (Holmquist-Johnson, 2004). The USBR was interested in testing BORAMEP with data collected on the LFCC. The analysis of the LFCC revealed error messages, which were generated by the program when it terminated the total load calculation (Jay, 2005). In most occasions, the analysis showed that the average total sediment load calculated by BORAMEP was lower than the measured load at the sampling sills (LF-FB and LF-VB). This occurred because BORAMEP could not determine the total load when the program was terminated due to an error message. Therefore, Jay used the suspended sediment load equation to calculate total sediment load at a given vertical. On occasion it was unclear why an error message occurred.

These data from the LFCC collected by the USBR were used in testing the variability of total load using BORAMEP. This analysis was conducted to determine the range and limitations of the program for use in sand bed channels. The primary conclusions of the work are:

1. The most suitable cross section was LF-11 for a discharge of 300 cfs. Vertical profiles LF-11A at station 48 to 63, LF-11B at station 42.5 to 45.5 and LF-11C at station 48 to 63 were selected as the best verticals. This is because, when using BORAMEP, these verticals gave no errors during initial total load calculations. Finally, the percent overlap between the measured suspended sediment and bed load was varied from 0 to 5% for all verticals at

cross section LF-11. Based on the results, minimal errors occurred when the percent overlap was within the range of 1 to 2%. The data indicated that the total sediment load varies by a maximum of 9%.

2. A sensitivity analysis was performed on several BORAMEP input parameters. The following parameters (and combinations thereof) were varied to develop fifteen permutations at 1.3 percent overlap: flow depth, width, discharge, mean flow velocity, concentration, vertical sampling depth, d_{35}, d_{65}, and water temperature. When depth, width, discharge and mean flow velocity were independently modified, the program calculated total load even though continuity was violated. Occasionally total load was calculated even when d_{35} was greater than d_{65}. Results indicated that water temperature had little effect on total load. However, total load was calculated when water temperatures were below freezing (32ºF). Reasonable results were found when combinations of flow depth, vertical sampling depth, width, discharge and mean flow velocity were modified to satisfy continuity. In these trials total load increased linearly with an increase in discharge or mean flow velocity. When discharge and mean flow velocity were increased, total load increased following a power function. As measured suspended sediment concentration increased, total load increased linearly as expected. Finally, as flow depth and vertical sampling depth were increased, total load decreased. However, in most scenarios error messages occurred that did not clearly explain the reason for BORAMEP's inability to calculate total load.
3. Finally, a list of ten recommendations has been generated and is provided in Table 4.21. These recommendations are based on the fact that BORAMEP calculated total sediment load under conditions, which are not physically possible or gave an error message that did not explain the situation.

Occasionally, total load was calculated when continuity was violated and when flow depth did not equal measured and unmeasured depth. As particle size was modified, total sediment loads were occasionally calculated when d_{35} was greater than d_{65} and when d_{35} and d_{65} were outside the measured particle distribution. In addition, the program could not calculate total load when concentration, channel depth, channel width, discharge or velocity were set to zero. In all these cases the total load should have been calculated as zero. Finally, there is no criterion for incipient motion within the program.

5.1 Recommendations

Based on detailed analyses of the BORAMEP program, the following recommendations will improve the computer code:

1. Based on the analysis of percent of overlap, it was determined that there was little variation in total sediment load when percent of overlap was changed. Thus a looping program should be added that lowers the percent of overlap until a total load can be calculated.
2. From analysis of the computer code it is evident that one of the necessary equations for determining the x factor needs to be revisited. The calculation of $\sqrt{RS_f}$ should have been written within the "Do Loop".
3. BORAMEP is best used in channels where there is significant overlap between the bed material and suspended sediment sample for reduced errors.
4. The program should require that there are a minimum of three overlapping bins to reduce negative exponent errors during the regression analysis of z to ω.

5. Further analysis of the computer program (BORAMEP) and the Modified Einstein Procedure are necessary to determine if the program is modeled appropriately.

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APPENDIX A – Equations used in BORAMEP

Modified Einstein Equations and Procedure

The information presented in this appendix is taken directly from the Program Manual written by the Bureau of Reclamation on BORAMEP. The following essential steps and fundamental equations represent what the USBR used to create the program code.

1) Compute the measured suspended load:

$$Q_s = 0.0027\ Q\ Conc\ \ (tons/day) \qquad \text{Equation A-1}$$

Where:

Q_s = measured suspended sediment load (tons/day);

Q= discharge (cfs);

Conc = suspended sediment concentration (mg/l).

2) Compute the product of the hydraulic radius and friction slope assuming x = 1:

2a) First, compute the value of $\sqrt{(RS_f}$ using the Einstein Equation:

$$\sqrt{(RS_f} = \frac{V_{avg}}{32.63\log\left[12.27\frac{h}{k_s}x\right]} \qquad \text{Equation A-2}$$

Where:

(RS_f)= hydraulic radius-slope parameter(ft);

V_{avg} = average stream velocity (ft/s);

h = flow depth (ft);

x= dimensionless parameter; and

k_s= effective roughness.

2b) Compute the shear velocity:

$$U_* = \sqrt{g(RS_f)}$$ Equation A-3

Where:

U_* = *Shear Velocity (ft/s);*

g= acceleration due to gravity (ft/s2); and

(RS_f)= slope-hydraulic radius function.

2c) Compute the laminar sublayer thickness δ:

$$\delta = \frac{11.6v}{U_*}$$ Equation A-4

Where:

δ = *sublayer thicikness (ft);*

v= kinematic viscosity (ft^2/s); and

U_*= shear velocity (ft/s).

2d) Recheck x to make sure that the initial guess is valid. Check Figure 2.1 (Einstein's Plate #3) for a value of x given k_s / δ or use the equation to determine the value of x. This is a trial and error process to determine the value of x and is carried out by the program using a solver routine.

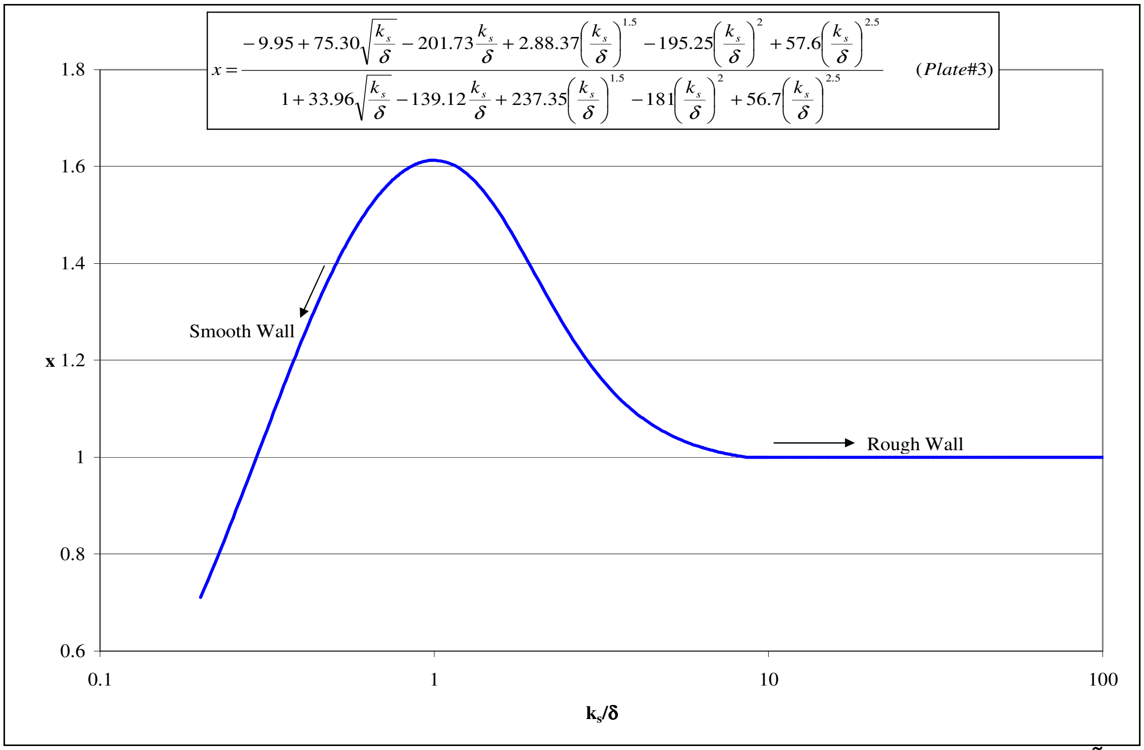


Figure A.1 – Correction x in the logarithmic friction formula in terms of $k_s/\tilde{\delta}$

3) Compute the value of P:

$$P = 2.303\log\left[30.2\frac{hx}{k_s}\right] \qquad \text{Equation A-5}$$

Where:

P = Transport Parameter;

h = flow depth (ft);

x = dimensionless parameter; and

k_s = effective roughness equal to d_{65}.

4) Compute the fraction of the flow depth not sampled (A'):

$$A' = \frac{d_n}{d_s} \qquad \text{Equation A-6}$$

Where:

A' = Fraction of Flow depth not sampled;

d_n = *vertical distance not sampled; and*

d_s = *vertical distance sampled .*

5) Compute the sediment discharge Q's through the sampled zone. This is calculated using a percentage of the flow sampled determined from the appropriate equation for the value of A' and P.

$$Q'_{s\,total} = Q_s * P_{fs} \qquad \text{Equation A-7}$$

P_{sf} = *Percent Flow Sampled*

$Q'_{s\,total}$ = *Total suspended sediment load in sampled zone*

For P=6,

$$P_{sf} = \frac{100 - 2941.79A'^2 + 265357.48A'^4 + 64219.08A'^6 - 325482.24A'^8}{1 - 29.38A'^2 + 2621.48A'^4 + 5407.23A'^6 + 157.44A'^8 + 1272.32A'^{10}} \qquad \text{Equation A-8}$$

For P=8,

$$P_{sf} = \frac{100 + 30991.16A'^2 + 21184.18A'^4 + 211800.14A'^6 - 263775.36A'^8}{1 + 325.87A'^2 + 1201.21A'^4 + 1872.11A'^6 + 5759.38A'^8 - 2976.45A'^{10}} \qquad \text{Equation A-9}$$

For P=11,

$$P_{sf} = \frac{100.19 + 31425.83A'^2 - 54359.86A'^4 + 1566703.2A'^6 - 1543898.1A'^8}{1 + 336.12A'^2 + 444.29A'^4 + 15662.05A'^6 + 18936.5A'^8 - 5820.32A'^{10}} \qquad \text{Equation A-10}$$

For P=14, %;

$$P_{sf} = \frac{100.31 + 45744.98A'^2 + 103307.39A'^4 + 635604.51A'^6 - 784215.44A'^8}{1 + 485A'^2 + 2934.57A'^4 + 7640.27A'^6 + 11737.99A'^8 - 3015.81A'^{10}} \qquad \text{Equation A-11}$$

6) Compute the bed-load for each size fraction:

6a) The first step in computing the bedload is to calculate the shear intensity (ψ) for all particle sizes in the analysis. ψ is calculated using the greater of the following two equations for all size classes.

$$\psi = 1.65\left(\frac{d_{35}}{RS_f}\right) \quad or \quad 0.66\left(\frac{d_i}{RS_f}\right) \qquad \text{Equation A-12}$$

Where:

d_{35} = particle size at, which 35 percent of the bed material by weight is finer (ft);

(RS_f)= hydraulic radius-slope parameter; and

d_i = the geometric mean for each size class (ft).

6b) Compute ½ of the intensity of the bed-load transport (φ) using the following equation.

$$\phi_* = \frac{0.023p}{(1-p)} \qquad \text{Equation A-13}$$

Where p is the probability a sediment particle is entrained in the flow and is calculated using the following version of the Error Function (Yang,1996):

$$p = 1 - \frac{1}{\sqrt{\pi}}\int_a^b e^{-t^2}dt \qquad \text{Equation A-14}$$

Where:

$$a = -\frac{B_*}{\psi} - \frac{1}{\eta_0}; \text{ and}$$

$$b = \frac{B_*}{\psi} - \frac{1}{\eta_0}.$$

and B_* is equal to a value of 0.143 and η_0 is equal to a value of 0.5.

Note: The Error Function is computed as the following integral.

$$ERF = \frac{2}{\sqrt{\pi}}\int_a^b e^{-t^2}dt \qquad \text{Equation A-15}$$

Therefore, to compute the probability "p", evaluate the Error function from a to b. Then, multiply the Error Function by ½ and subtract it from 1.

6c) Compute the unit bed-load for each size fraction using the following equation:

$$i_B q_B = 1200 d_i^{3/2} i_B \frac{\phi_*}{2}$$ Equation A-16

Where:

$i_b q_b$ = *sediment discharge through the bed layer (lb/s per foot of width*

d_i = *geometric mean diameter of a size range (ft);*

i_b = *fraction of bed material in a given size range; and*

$\phi_*/2$ = *intensity of bedload transport for individual grain size.*

6d) Compute the bed-load for each size fraction in Tons/Day by multiplying by the conversion factor 43.2 and the channel width.

$$Q'_{Bi} = i_B q_B (43.2W)$$ Equation A-17

Where:

Q'_{Bi} = *sediment load by size fraction through the bed layer; and*

W = *channel width (ft).*

7) Compute Suspended Load (Q'_{si}) for each size fraction by multiplying the total sampled suspended load ($Q'_{s\,total}$) by the suspended load fractions for the sample.

$$Q'_{si} = i_s\, Q'_{s\,total}$$

Equation A-18

Where:

i_s = *fraction of suspended material in a given size range; and*

Q'_{si} = *suspended sediment load by size fraction (tons/day).*

8) Compute the theoretical exponent for vertical distribution of sediment (Z). This process is a trial and error method. **Note:** The original USBR method from 1955 provided a figure (Plate 8) to determine Z (termed Z' in the initial calculations) by computing the ratio of the suspended load ($Q_s^{'}$) to the bed-load ($i_B Q_B$) for each size class. However, Plate 8 was based solely on data from the Niobrara River near Cody, Nebraska. A subsequent study completed by the USBR in 1966 (Computation of Z's for use in the Modified Einstein Procedure) determined that using the regression line in Plate 8 produced errors on the order of 20% for the total load. Therefore, the following process determines the Z-values only by trial and error. Reasonable assumptions should be bound between approximately 0.01 and 1.8 as this was the range of Z' from the original Plate 8.

8a) Compute the ratio $\frac{Q_s^{'}}{i_B Q_B}$ for all size classes with suspended load transport.

8b) Size classes that have calculated values for the ratio of the suspended load to the bed-load are used as the reference ranges for Z-value computations. However, if any of the ratios is for a size range less than sand/silt split of 0.0625 it should not be used since the sediment in this size range is considered wash load and not found in large quantities in the bed.

The ratio of suspended load to bed-load is set equal to a function with the parameters $I_1^{''}, J_1^{''}, J_1^{''}, J_2^{'}$ as the following (USBR,1955):

$$\frac{Q_s^{'}}{i_B\, Q_B} = \frac{I_1^{''}}{J_1^{''}}\left(PJ_1^{'} + J_2^{'}\right) \qquad \text{Equation A-19}$$

Where:

I_1" = *mathematical abbreviation that contains J_1" and A";*

J_1" = *mathematical abbreviation that contains A";*

J_1' = *mathematical abbreviation that contains A';*

J_2' = *mathematical abbreviation that contains A'; and*

P = *mathematic abbreviation for equation A-5.*

Due to the lack of computer resources available in 1955 to explicitly solve the integral form of the equations for $I_1^{''}, J_1^{''}, J_1^{''}, J_2^{'}$, these values were read from plates 9-11 from the 1955 Bureau publication. However, current computer technology allows for an explicit solution to these integrals, which results in a more precise answer to the parameters compared to reading the values off the plates by hand. The dependent variables for these parameters are $A^{'}$ and $A^{''}$. $A^{'}$ has previously been computed. $A^{''}$ is calculated as the following for each size class:

$$A^{''} = \frac{2\,d_i}{h} \qquad \text{Equation A-20}$$

Where:

d_i = *geometric mean diameter of a size range (ft); and*

h = *flow depth (ft).*

For each size class an initial Z-value must be assumed and then the following equations are used to determine the parameters contained in plates 9-11. In order to provide some guidance in the initial guess of the Z-value, the following equation is used (from Einstein's Plate #8):

$$Z_{guess} = -0.1465\ln\left(\frac{Q_s^{'}}{i_B Q_B}\right) + 1.0844 \qquad \text{Equation A-21}$$

Using the initial guess for the Z-values and the equations given below for $I_1^{''}, J_1^{''}, J_1^{''}, J_2^{'}$, a trial and error process is carried out for each size class using a solver routine to determine the value of Z by minimizing the difference between the ratio $\frac{Q_s^{'}}{i_B\, Q_B}$ and $\frac{I_1^{''}}{J_1^{''}}\left(PJ_1^{'} + J_2^{'}\right)$.

$$I_1^{''} = 0.216\frac{A^{''(z-1)}}{(1-A^{''})^z} J_1^{''} \qquad \text{Equation A-22}$$

$$J_1^{'} = \int_{A'}^{1}\left(\frac{1-y}{y}\right)^z dy \qquad \text{Equation A-23}$$

$$J_1^{''} = \int_{A''}^{1}\left(\frac{1-y}{y}\right)^z \log_e(y)dy \qquad \text{Equation A-24}$$

$$-J_2^{'} = \int_{A'}^{1}\left(\frac{1-y}{y}\right)^z \log_e(y)dy \qquad \text{Equation A-25}$$

$$-J_2^{''} = \int_{A''}^{1}\left(\frac{1-y}{y}\right)^z \log_e(y)dy \qquad \text{Equation A-26}$$

8c) Once the Z-values have been determined for the suspended load, a log-log plot is made of the relationship between Z and the fall velocity for each size class. A power function equation is then developed such that $Z = a\,\omega^b$. The remaining Z-values for the bed-load are computed using this relationship. The fall velocity is computed using Rubey's Equation.

$$\omega = F\left[d_i\, g\left(\frac{\gamma_s - \gamma}{\gamma}\right)\right]^{1/2} \qquad \text{Equation A-27}$$

Where:

F = *mathematical abbreviation for equation 2-28;*

g = *acceleration due to gravity (ft/s²);*

d_i = *geometric mean diameter of a size range (ft); and*

γ_s = *specific weight of sediment (lb/ft³); and*

γ = *specific weight of water (lb/ft³).*

$$F = \left[\frac{2}{3} + \frac{36\nu^2}{g\, d^3\left(\frac{\gamma_s}{\gamma} - 1\right)}\right]^{1/2} - \left[\frac{36\nu^2}{g\, d^3\left(\frac{\gamma_s}{\gamma} - 1\right)}\right]^{1/2} \qquad \text{Equation A-28}$$

Figure A.2 is an example plot of three suspended load points indicating the power function regression relationship $Z = a\,\omega^b$ and the resulting Z-values that are calculating using the regression equation.

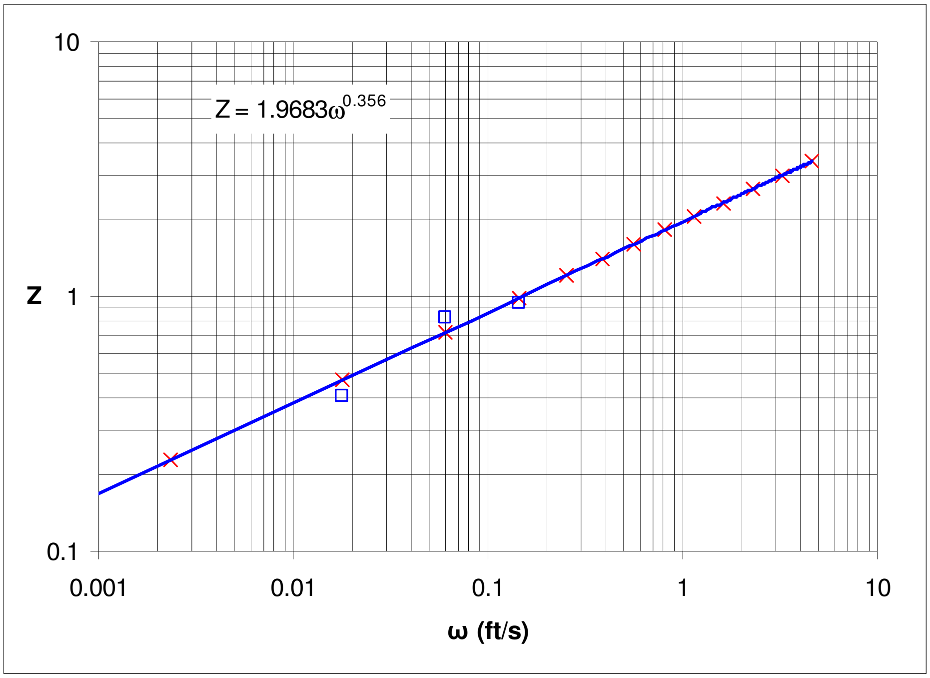


Figure A.2 – Z-value Regression Analysis

9) Compute the total sediment load.

9a) Calculate the total load due to suspended sediment. Calculate the ratio $\frac{\left(P\,J_1^{"} + J_2^{"}\right)}{\left(P\,J_1^{'} + J_2^{'}\right)}$ for the size classes used in determining the z-values for suspended load and smaller and multiply this ratio by the computed suspended sediment for each size class as calculated in step 7 of this procedure to compute the total load due to suspended sediment.

$$Qs_{total\ suspended} = Q_s^{'}\,\frac{\left(P\,J_1^{"} + J_2^{"}\right)}{\left(P\,J_1^{'} + J_2^{'}\right)} \qquad \text{Equation A-29}$$

9b) The total load for the remaining size classes are calculated using the computed bed-load. Using the Z-values calculated with the power function from step 8c, calculate $I_1^{"}$ and $-I_2^{"}$ using the following equations:

$$I_1^{"} = 0.216 \frac{A^{"(z-1)}}{(1-A^{"})^z} J_1^{"}$$ Equation A-30

$$-I_2^{"} = 0.216 \frac{A^{"(z-1)}}{(1-A^{"})^z} J_2^{"}$$ Equation A-31

Then, compute the value $\left(P I_1^{"} + I_2^{"} + 1\right)$ and multiply by the computed bed-load for that size class to compute the total load due to bed-load.

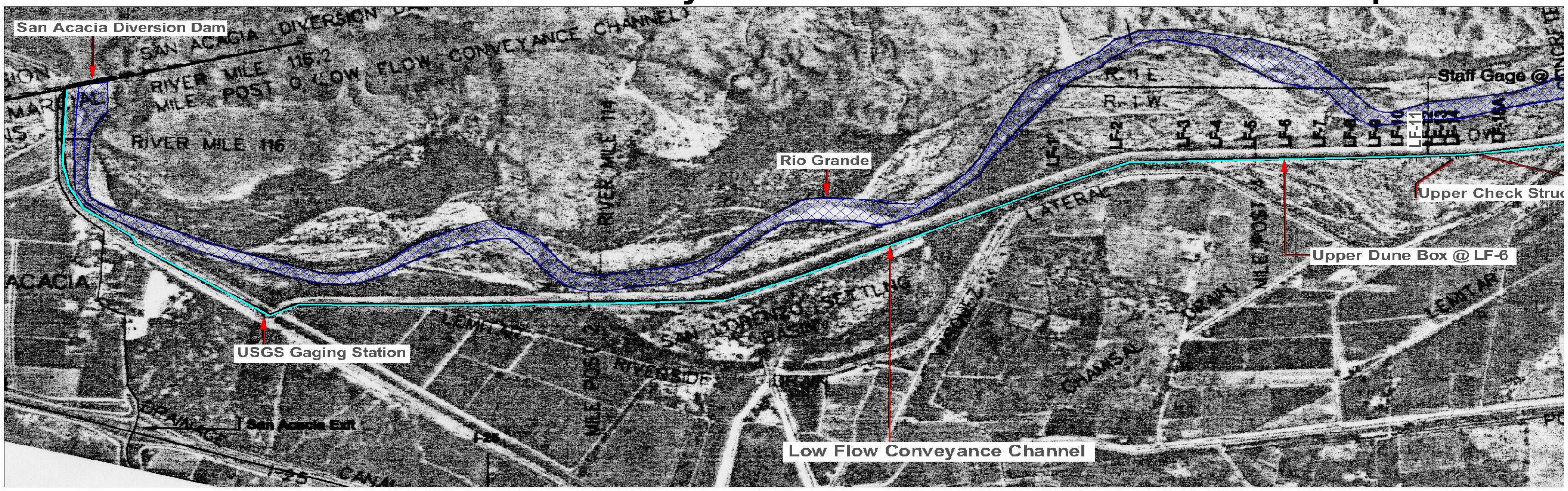
$$Qs_{total\ bed} = Q_B^{'} \left(P I_1^{"} + I_2^{"} + 1\right)$$ Equation A-32

9c) The total load is then the sum of the total suspended and total bed load.

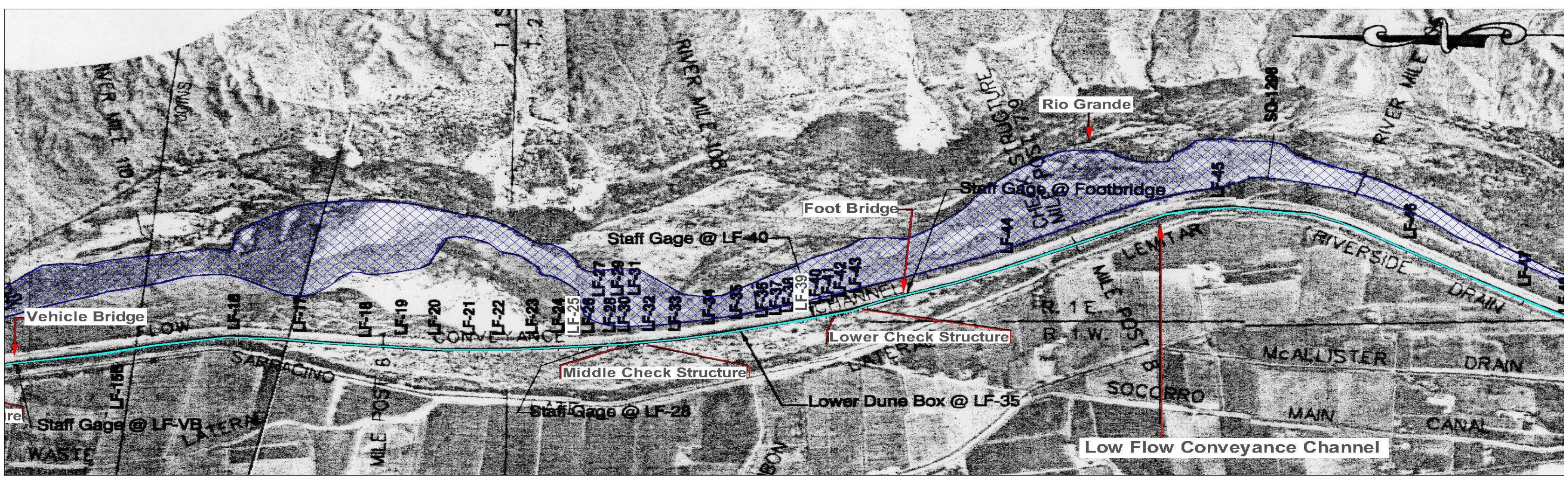
$$Qs_{total} = \sum Qs_{total\ suspended} + \sum Qs_{total\ bed}$$ Equation A-33

APPENDIX B – Cross Section Location Map of Low Flow Conveyance Channel

Low Flow Conveyance Channel Cross Section Location Map



Upstream Portion of Low Flow Conveyance Channel (Source Tetra Tech)
1 INCH = 2500 FEET



Downstream Portion of Low Flow Conveyance Channel (Source Tetra Tech)

APPENDIX C – Initial BORAMEP Input Data Sheet

Table C.1 – Size Class Range Based on Bin Number		
Bin Number	Size Class Range (mm)	
	Lower Limit	Upper Limit
Bin 1	0.001	0.002
Bin 2	0.002	0.004
Bin 3	0.004	0.016
Bin 4	0.016	0.0625
Bin 5	0.0625	0.125
Bin 6	0.125	0.25
Bin 7	0.25	0.5
Bin 8	0.5	1
Bin 9	1	2
Bin 10	2	4
Bin 11	4	8
Bin 12	8	16
Bin 13	16	32
Bin 14	32	64
Bin 15	64	128
Bin 16	128	256

Table C.2 – Measured Data Input for LFCC for 300 cfs							
Title[1]	Sf	g (ft/s^2)	γ_w (lb/ft^3)	γ_s (lb/ft^3)	Q (cfs)	V_{avg} (ft/s)	h (ft)
LF-11A-20-32	0.0008	32.17	62.4	165	38.098	1.322847	3.3
LF-11A-32-36.5	0.0008	32.17	62.4	165	51.5175	2.206317	5.7
LF-11A-36.5-39.5	0.0008	32.17	62.4	165	35.7575	2.48316	5.9
LF-11A-39.5-42.5	0.0008	32.17	62.4	165	35.265	2.501064	5.7
LF-11A-42.5-45.5	0.0008	32.17	62.4	165	32.2025	2.275795	6
LF-11A-45.5-48	0.0008	32.17	62.4	165	26.3675	2.179132	5.7
LF-11A-48-63	0.0008	32.17	62.4	165	53.535	1.476828	3.1
LF-11B-20-32	0.0008	32.17	62.4	165	33.168	1.13589	4.5
LF-11B-32-36.5	0.0008	32.17	62.4	165	46.11	1.996104	5.3
LF-11B-36.5-39.5	0.0008	32.17	62.4	165	32.465	2.114984	5.1
LF-11B-39.5-42.5	0.0008	32.17	62.4	165	32.55	2.191919	5.2
LF-11B-42.5-45.5	0.0008	32.17	62.4	165	34.5975	2.155607	5.4
LF-11B-45.5-48	0.0008	32.17	62.4	165	26.8075	1.993123	5.4
LF-11B-48-63	0.0008	32.17	62.4	165	56.41	1.451995	4.4
LF-11C-20-32	0.0008	32.17	62.4	165	35.127	1.232526	4.5
LF-11C-32-36.5	0.0008	32.17	62.4	165	49.1125	2.144651	5.2
LF-11C-36.5-39.5	0.0008	32.17	62.4	165	35.6	2.289389	5.2
LF-11C-39.5-42.5	0.0008	32.17	62.4	165	35.2575	2.196729	5.4
LF-11C-42.5-45.5	0.0008	32.17	62.4	165	35.53	2.036103	5.9
LF-11C-45.5-48	0.0008	32.17	62.4	165	28.845	2.024211	5.7
LF-11C-48-63	0.0008	32.17	62.4	165	60.688	1.570194	3.4
LF-39A-11-29	0.0008	32.17	62.4	165	51.6076	0.936617	4.9
LF-39A-29-34.5	0.0008	32.17	62.4	165	43.11	1.738306	4.7
LF-39A-34.5-39.5	0.0008	32.17	62.4	165	40.5525	1.839116	4.8
LF-39A-39.5-44.5	0.0008	32.17	62.4	165	42.91	1.907111	4.5
LF-39A-44.5-49.5	0.0008	32.17	62.4	165	36.2025	1.757403	4.4
LF-39A-49.5-56	0.0008	32.17	62.4	165	38.005	1.487476	3.9
LF-39A-56-73	0.0008	32.17	62.4	165	37.589	0.702598	4.3
LF-39B-11-29	0.0008	32.17	62.4	165	54.871	1.005885	4.6
LF-39B-29-34.5	0.0008	32.17	62.4	165	41.595	1.677218	4.5
LF-39B-34.5-39.5	0.0008	32.17	62.4	165	39.4975	1.763281	4.5
LF-39B-39.5-44.5	0.0008	32.17	62.4	165	39.055	1.846572	4.2
LF-39B-44.5-49.5	0.0008	32.17	62.4	165	34.9575	1.806589	3.9
LF-39B-49.5-56	0.0008	32.17	62.4	165	36.385	1.467137	3.8
LF-39B-56-73	0.0008	32.17	62.4	165	31.026	0.653867	3.7
LF-39C-11-29	0.0008	32.17	62.4	165	55.6503	1.02017	4.5
LF-39C-29-34.5	0.0008	32.17	62.4	165	44.2025	1.761056	4.5
LF-39C-34.5-39.5	0.0008	32.17	62.4	165	42.485	1.888222	4.5
LF-39C-39.5-44.5	0.0008	32.17	62.4	165	40.08	1.913126	4.1
LF-39C-44.5-49.5	0.0008	32.17	62.4	165	34.7925	1.798062	3.9
LF-39C-49.5-56	0.0008	32.17	62.4	165	37.0205	1.48082	3.9
LF-39C-56-73	0.0008	32.17	62.4	165	32.4405	0.649459	3.8
LF-25A-8-25	0.0008	32.17	62.4	165	34.183	0.601813	5.2
LF-25A-25-30.5	0.0008	32.17	62.4	165	8.0585	0.328918	4.6

Table C.2 – Measured Data Input for LFCC for 300 cfs							
Title[1]	Sf	g (ft/s^2)	γ_w (lb/ft^3)	γ_s (lb/ft^3)	Q (cfs)	V_{avg} (ft/s)	h (ft)
LF-25A-30.5-36	0.0008	32.17	62.4	165	41.1055	1.264785	6
LF-25A-36-42	0.0008	32.17	62.4	165	56.59	1.550411	6.1
LF-25A-42-48	0.0008	32.17	62.4	165	60.045	1.663296	6
LF-25A-48-54	0.0008	32.17	62.4	165	54.32	1.492308	6
LF-25A-54-68	0.0008	32.17	62.4	165	33.032	0.702809	5.4
LF-25B-8-25	0.0008	32.17	62.4	165	26.159	0.479103	4.9
LF-25B-25-30.5	0.0008	32.17	62.4	165	9.1135	0.382117	4.3
LF-25B-30.5-36	0.0008	32.17	62.4	165	32.8295	1.050544	5.8
LF-25B-36-42	0.0008	32.17	62.4	165	57.92	1.604432	6
LF-25B-42-48	0.0008	32.17	62.4	165	62.15	1.726389	6
LF-25B-48-54	0.0008	32.17	62.4	165	55.425	1.531077	6.1
LF-25B-54-68	0.0008	32.17	62.4	165	28.853	0.596136	5.3
LF-25C-8-25	0.0008	32.17	62.4	165	34.744	0.614938	4.9
LF-25C-25-30.5	0.0008	32.17	62.4	165	10.898	0.447556	4.4
LF-25C-30.5-36	0.0008	32.17	62.4	165	34.056	1.082862	5.8
LF-25C-36-42	0.0008	32.17	62.4	165	56.975	1.582639	6
LF-25C-42-48	0.0008	32.17	62.4	165	58.14	1.610526	6
LF-25C-48-54	0.0008	32.17	62.4	165	54.41	1.490685	6.1
LF-25C-54-68	0.0008	32.17	62.4	165	31.478	0.642408	5.2

Table C.2 – Measured Data Input for LFCC for 300 cfs							
Title[1]	W (ft)	T (F)	dn (ft)	Cs (ppm)	d65 (mm)	d35 (mm)	ds (ft)
LF-11A-20-32	12	72	0.3	354.4615	0.9	0.34	3
LF-11A-32-36.5	4.5	72	0.3	443.125	0.21	0.15	5.4
LF-11A-36.5-39.5	3	72	0.3	421.4545	0.18	0.14	5.6
LF-11A-39.5-42.5	3	72	0.3	451.6923	0.16	0.12	5.4
LF-11A-42.5-45.5	3	72	0.3	411.7188	0.18	0.14	5.7
LF-11A-45.5-48	2.5	72	0.3	391.4085	0.21	0.15	5.4
LF-11A-48-63	15	72	0.3	392.48	0.2	0.15	2.8
LF-11B-20-32	12	72	0.3	274.7619	0.18	0.14	4.2
LF-11B-32-36.5	4.5	72	0.3	296.6667	0.19	0.15	5
LF-11B-36.5-39.5	3	72	0.3	322	0.21	0.16	4.8
LF-11B-39.5-42.5	3	72	0.3	290.8475	0.17	0.14	4.9
LF-11B-42.5-45.5	3	72	0.3	256	0.18	0.15	5.1
LF-11B-45.5-48	2.5	72	0.3	298.6207	0.22	0.17	5.1
LF-11B-48-63	15	72	0.3	295.0769	0.21	0.16	4.1
LF-11C-20-32	12	72	0.3	245.2083	0.12	0.001	4.2
LF-11C-32-36.5	4.5	72	0.3	237.6238	0.19	0.15	4.9
LF-11C-36.5-39.5	3	72	0.3	203.4247	0.19	0.15	4.9
LF-11C-39.5-42.5	3	72	0.3	291.6667	0.18	0.14	5.1
LF-11C-42.5-45.5	3	72	0.3	299.3985	0.21	0.16	5.6
LF-11C-45.5-48	2.5	72	0.3	267.8912	0.22	0.16	5.4

Table C.2 – Measured Data Input for LFCC for 300 cfs							
Title[1]	W (ft)	T (F)	dn (ft)	Cs (ppm)	d65 (mm)	d35 (mm)	ds (ft)
LF-11C-48-63	15	72	0.3	255.3846	0.22	0.16	3.1
LF-39A-11-29	18	72	0.3	132.0408	0.31	0.22	4.6
LF-39A-29-34.5	5.5	72	0.3	149.6226	0.32	0.24	4.4
LF-39A-34.5-39.5	5	72	0.3	169.0909	0.33	0.25	4.5
LF-39A-39.5-44.5	5	72	0.3	169.1667	0.08	0.033	4.2
LF-39A-44.5-49.5	5	72	0.3	184.7368	0.24	0.17	4.1
LF-39A-49.5-56	6.5	72	0.3	178.125	0.3	0.2	3.6
LF-39A-56-73	17	72	0.3	184.5833	0.32	0.24	4
LF-39B-11-29	18	73	0.3	151.8033	0.31	0.21	4.3
LF-39B-29-34.5	5.5	73	0.3	171.0667	0.31	0.22	4.2
LF-39B-34.5-39.5	5	73	0.3	162.0635	0.32	0.23	4.2
LF-39B-39.5-44.5	5	73	0.3	151.8966	0.1	0.064	3.9
LF-39B-44.5-49.5	5	73	0.3	157.6364	0.22	0.16	3.6
LF-39B-49.5-56	6.5	73	0.3	158.6275	0.27	0.18	3.5
LF-39B-56-73	17	73	0.3	210.2	0.33	0.26	3.4
LF-39C-11-29	18	72	0.3	163.7255	0.31	0.21	4.2
LF-39C-29-34.5	5.5	72	0.3	163.0303	0.34	0.27	4.2
LF-39C-34.5-39.5	5	72	0.3	168.2258	0.32	0.22	4.2
LF-39C-39.5-44.5	5	72	0.3	170.1639	0.14	0.088	3.8
LF-39C-44.5-49.5	5	72	0.3	166.2069	0.29	0.2	3.6
LF-39C-49.5-56	6.5	72	0.3	163.8	0.28	0.19	3.6
LF-39C-56-73	17	72	0.3	178.9091	0.34	0.27	3.5
LF-25A-8-25	17	73	0.3	60.36036	0.06	0.028	4.9
LF-25A-25-30.5	5.5	73	0.3	1805.094	0.081	0.049	4.3
LF-25A-30.5-36	5.5	73	0.3	1690.455	0.32	0.21	5.7
LF-25A-36-42	6	73	0.3	1734.217	0.11	0.072	5.8
LF-25A-42-48	6	73	0.3	1643.04	0.35	0.28	5.7
LF-25A-48-54	6	73	0.3	1670	0.3	0.19	5.7
LF-25A-54-68	14	73	0.3	1687.048	0.34	0.26	5.1
LF-25B-8-25	17	73	0.3	1548.028	0.09	0.05	4.6
LF-25B-25-30.5	5.5	73	0.3	1584.375	0.083	0.044	4
LF-25B-30.5-36	5.5	73	0.3	1677.557	0.26	0.15	5.5
LF-25B-36-42	6	73	0.3	1674.513	0.17	0.11	5.7
LF-25B-42-48	6	73	0.3	1599.484	0.33	0.26	5.7
LF-25B-48-54	6	73	0.3	1591.884	0.26	0.15	5.8
LF-25B-54-68	14	73	0.3	1560.694	0.32	0.22	5
LF-25C-8-25	17	73	0.3	1589.55	0.1	0.035	4.6
LF-25C-25-30.5	5.5	73	0.3	1623.636	0.078	0.045	4.1
LF-25C-30.5-36	5.5	73	0.3	1538.767	0.26	0.14	5.5
LF-25C-36-42	6	73	0.3	1578	0.14	0.068	5.7
LF-25C-42-48	6	73	0.3	1517.143	0.36	0.28	5.7
LF-25C-48-54	6	73	0.3	1528.971	0.12	0.03	5.8
LF-25C-54-68	14	73	0.3	1575.769	0.32	0.23	4.9

Table C.3 – Measured Bed Material for LFCC for 300 cfs								
Title[1]	bed bin1	bed bin2	bed bin3	bed bin4	bed bin5	bed bin6	bed bin7	bed bin8
LF-11A-20-32	0	0	0	0.090	0.701	19.324	28.459	19.156
LF-11A-32-36.5	0	0	0	0.116	2.429	74.429	22.908	0.025
LF-11A-36.5-39.5	0	0	0	0.144	2.945	93.892	3.019	0.000
LF-11A-39.5-42.5	0	0	0	0.191	2.578	82.400	14.815	0.013
LF-11A-42.5-45.5	0	0	0	0.190	3.973	94.280	1.557	0.000
LF-11A-45.5-48	0	0	0	0.083	2.147	76.392	20.494	0.378
LF-11A-48-63	0	0	0	2.810	17.888	78.503	0.766	0.017
LF-11B-20-32	0	0	0	2.261	10.557	82.428	1.398	1.307
LF-11B-32-36.5	0	0	0	0.139	3.235	89.081	7.437	0.029
LF-11B-36.5-39.5	0	0	0	0.366	3.059	75.099	21.408	0.044
LF-11B-39.5-42.5	0	0	0	0.043	2.441	76.827	20.650	0.033
LF-11B-42.5-45.5	0	0	0	0.195	5.718	92.480	1.597	0.007
LF-11B-45.5-48	0	0	0	0.086	1.877	67.957	25.871	3.776
LF-11B-48-63	0	0	0	1.511	15.090	81.390	1.908	0.027
LF-11C-20-32	0	0	0	56.579	8.114	33.114	1.974	0.000
LF-11C-32-36.5	0	0	0	0.168	3.307	86.653	9.416	0.194
LF-11C-36.5-39.5	0	0	0	0.223	2.851	84.634	11.039	0.506
LF-11C-39.5-42.5	0	0	0	0.620	2.099	69.428	26.565	0.834
LF-11C-42.5-45.5	0	0	0	0.081	1.986	75.835	21.704	0.114
LF-11C-45.5-48	0	0	0	0.117	2.353	68.682	28.387	0.164
LF-11C-48-63	0	0	0	1.499	10.032	83.511	4.864	0.036
LF-39A-11-29	0	0	0	0.735	2.749	37.886	57.034	1.489
LF-39A-29-34.5	0	0	0	0.174	1.005	29.922	65.747	2.785
LF-39A-34.5-39.5	0	0	0	0.084	0.643	27.237	66.611	4.610
LF-39A-39.5-44.5	0	0	0	0.167	1.621	29.631	66.212	2.286
LF-39A-44.5-49.5	0	0	0	0.253	8.322	53.965	35.792	1.399
LF-39A-49.5-56	0	0	0	0.359	3.501	44.683	48.599	2.264
LF-39A-56-73	0	0	0	54.092	31.357	13.527	1.025	0.000
LF-39B-11-29	0	0	0	1.664	5.409	36.049	56.183	0.668
LF-39B-29-34.5	0	0	0	0.191	1.354	41.146	55.103	2.031
LF-39B-34.5-39.5	0	0	0	0.090	0.812	36.088	59.523	3.067
LF-39B-39.5-44.5	0	0	0	0.462	0.888	26.967	68.111	3.329
LF-39B-44.5-49.5	0	0	0	0.380	7.648	62.516	28.551	0.826
LF-39B-49.5-56	0	0	0	0.646	4.328	51.519	40.898	1.966
LF-39B-56-73	0	0	0	31.357	42.354	14.676	5.373	4.147
LF-39C-11-29	0	0	0	0.711	3.028	41.513	52.934	1.706
LF-39C-29-34.5	0	0	0	0.210	1.160	24.843	69.796	3.527
LF-39C-34.5-39.5	0	0	0	0.333	1.381	38.647	56.021	2.943
LF-39C-39.5-44.5	0	0	0	0.140	1.028	25.614	69.103	3.755
LF-39C-44.5-49.5	0	0	0	0.332	7.167	43.871	47.657	0.860
LF-39C-49.5-56	0	0	0	0.455	4.221	50.267	42.584	1.921
LF-39C-56-73	0	0	0	18.913	32.764	36.107	6.260	3.313
LF-25A-8-25	0	0	0	65.873	24.491	6.424	3.212	0.000
LF-25A-25-30.5	0	0	0	48.877	36.904	11.850	2.370	0.000
LF-25A-30.5-36	0	0	0	4.037	10.480	26.082	51.075	3.627
LF-25A-36-42	0	0	0	1.245	6.019	22.455	64.822	3.761

Table C.3 – Measured Bed Material for LFCC for 300 cfs								
Title[1]	bed bin1	bed bin2	bed bin3	bed bin4	bed bin5	bed bin6	bed bin7	bed bin8
LF-25A-42-48	0	0	0	0.685	4.618	19.938	66.980	4.726
LF-25A-48-54	0	0	0	15.116	8.638	23.090	51.993	0.000
LF-25A-54-68	0	0	0	22.062	45.483	18.830	9.117	4.492
LF-25B-8-25	0	0	0	45.382	32.154	20.262	2.202	0.000
LF-25B-25-30.5	0	0	0	48.519	30.000	17.778	3.704	0.000
LF-25B-30.5-36	0	0	0	3.560	17.960	36.700	36.760	1.960
LF-25B-36-42	0	0	0	4.438	5.882	27.403	54.678	5.231
LF-25B-42-48	0	0	0	0.543	4.158	21.585	68.673	3.548
LF-25B-48-54	0	0	0	5.762	14.176	39.123	34.146	2.358
LF-25B-54-68	0	0	0	10.858	27.478	47.742	9.946	1.669
LF-25C-8-25	0	0	0	50.949	21.519	25.000	2.532	0.000
LF-25C-25-30.5	0	0	0	51.428	33.923	10.023	4.626	0.000
LF-25C-30.5-36	0	0	0	5.740	18.580	33.965	37.400	2.210
LF-25C-36-42	0	0	0	2.720	6.143	26.517	58.773	4.352
LF-25C-42-48	0	0	0	1.537	3.954	18.218	64.042	6.852
LF-25C-48-54	0	0	0	45.402	12.834	35.195	1.375	2.397
LF-25C-54-68	0	0	0	32.533	22.231	26.098	19.138	0.000

Table C.3 – Measured Bed Material for LFCC for 300 cfs								
Title[1]	Bed bin9	Bed bin10	Bed bin11	Bed bin12	Bed bin13	Bed bin14	Bed bin15	Bed bin16
LF-11A-20-32	32.270	0.000	0.000	0	0	0	0	0
LF-11A-32-36.5	0.024	0.070	0.000	0	0	0	0	0
LF-11A-36.5-39.5	0.000	0.000	0.000	0	0	0	0	0
LF-11A-39.5-42.5	0.003	0.000	0.000	0	0	0	0	0
LF-11A-42.5-45.5	0.000	0.000	0.000	0	0	0	0	0
LF-11A-45.5-48	0.198	0.309	0.000	0	0	0	0	0
LF-11A-48-63	0.016	0.000	0.000	0	0	0	0	0
LF-11B-20-32	2.049	0.000	0.000	0	0	0	0	0
LF-11B-32-36.5	0.014	0.065	0.000	0	0	0	0	0
LF-11B-36.5-39.5	0.024	0.000	0.000	0	0	0	0	0
LF-11B-39.5-42.5	0.007	0.000	0.000	0	0	0	0	0
LF-11B-42.5-45.5	0.003	0.000	0.000	0	0	0	0	0
LF-11B-45.5-48	0.121	0.312	0.000	0	0	0	0	0
LF-11B-48-63	0.013	0.061	0.000	0	0	0	0	0
LF-11C-20-32	0.000	0.219	0.000	0	0	0	0	0
LF-11C-32-36.5	0.178	0.085	0.000	0	0	0	0	0
LF-11C-36.5-39.5	0.268	0.321	0.158	0	0	0	0	0
LF-11C-39.5-42.5	0.218	0.236	0.000	0	0	0	0	0
LF-11C-42.5-45.5	0.075	0.205	0.000	0	0	0	0	0
LF-11C-45.5-48	0.067	0.229	0.000	0	0	0	0	0
LF-11C-48-63	0.020	0.039	0.000	0	0	0	0	0
LF-39A-11-29	0.064	0.043	0.000	0	0	0	0	0
LF-39A-29-34.5	0.277	0.090	0.000	0	0	0	0	0
LF-39A-34.5-39.5	0.666	0.149	0.000	0	0	0	0	0
LF-39A-39.5-44.5	0.083	0.000	0.000	0	0	0	0	0
LF-39A-44.5-49.5	0.173	0.097	0.000	0	0	0	0	0
LF-39A-49.5-56	0.393	0.201	0.000	0	0	0	0	0

Table C.3 – Measured Bed Material for LFCC for 300 cfs								
Title[1]	Bed bin9	Bed bin10	Bed bin11	Bed bin12	Bed bin13	Bed bin14	Bed bin15	Bed bin16
LF-39A-56-73	0.000	0.000	0.000	0	0	0	0	0
LF-39B-11-29	0.027	0.000	0.000	0	0	0	0	0
LF-39B-29-34.5	0.149	0.026	0.000	0	0	0	0	0
LF-39B-34.5-39.5	0.349	0.071	0.000	0	0	0	0	0
LF-39B-39.5-44.5	0.187	0.056	0.000	0	0	0	0	0
LF-39B-44.5-49.5	0.079	0.000	0.000	0	0	0	0	0
LF-39B-49.5-56	0.357	0.286	0.000	0	0	0	0	0
LF-39B-56-73	2.093	0.000	0.000	0	0	0	0	0
LF-39C-11-29	0.083	0.025	0.000	0	0	0	0	0
LF-39C-29-34.5	0.368	0.096	0.000	0	0	0	0	0
LF-39C-34.5-39.5	0.543	0.133	0.000	0	0	0	0	0
LF-39C-39.5-44.5	0.314	0.045	0.000	0	0	0	0	0
LF-39C-44.5-49.5	0.082	0.029	0.000	0	0	0	0	0
LF-39C-49.5-56	0.335	0.216	0.000	0	0	0	0	0
LF-39C-56-73	2.297	0.347	0.000	0	0	0	0	0
LF-25A-8-25	0.000	0.000	0.000	0	0	0	0	0
LF-25A-25-30.5	0.000	0.000	0.000	0	0	0	0	0
LF-25A-30.5-36	1.750	1.528	1.420	0	0	0	0	0
LF-25A-36-42	1.342	0.355	0.000	0	0	0	0	0
LF-25A-42-48	1.868	1.186	0.000	0	0	0	0	0
LF-25A-48-54	0.000	1.163	0.000	0	0	0	0	0
LF-25A-54-68	0.016	0.000	0.000	0	0	0	0	0
LF-25B-8-25	0.000	0.000	0.000	0	0	0	0	0
LF-25B-25-30.5	0.000	0.000	0.000	0	0	0	0	0
LF-25B-30.5-36	1.560	1.500	0.000	0	0	0	0	0
LF-25B-36-42	1.346	1.023	0.000	0	0	0	0	0
LF-25B-42-48	1.022	0.392	0.080	0	0	0	0	0
LF-25B-48-54	1.730	2.705	0.000	0	0	0	0	0
LF-25B-54-68	1.120	1.187	0.000	0	0	0	0	0
LF-25C-8-25	0.000	0.000	0.000	0	0	0	0	0
LF-25C-25-30.5	0.000	0.000	0.000	0	0	0	0	0
LF-25C-30.5-36	1.133	0.970	0.000	0	0	0	0	0
LF-25C-36-42	0.938	0.385	0.173	0	0	0	0	0
LF-25C-42-48	2.190	1.060	2.146	0	0	0	0	0
LF-25C-48-54	1.296	1.177	0.324	0	0	0	0	0
LF-25C-54-68	0.000	0.000	0.000	0	0	0	0	0

Table C.4 – Measured Suspended Sediment for LFCC for 300 cfs								
Title[1]	sus bin1	sus bin2	sus bin3	sus bin4	sus bin5	sus bin6	sus bin7	sus bin8
LF-11A-20-32	0	0	0	68.056	20.877	9.766	0.694	0.608
LF-11A-32-36.5	0	0	0	55.458	18.166	24.654	1.100	0.621
LF-11A-36.5-39.5	0	0	0	62.899	25.453	8.240	2.545	0.863
LF-11A-39.5-42.5	0	0	0	52.793	16.144	26.873	1.601	2.589
LF-11A-42.5-45.5	0	0	0	58.292	15.446	23.529	1.973	0.759
LF-11A-45.5-48	0	0	0	63.980	15.905	17.452	2.051	0.612
LF-11A-48-63	0	0	0	61.150	17.203	11.659	2.772	7.216
LF-11B-20-32	0	0	0	64.356	20.797	12.016	1.329	1.502
LF-11B-32-36.5	0	0	0	63.456	18.245	15.142	1.338	1.819
LF-11B-36.5-39.5	0	0	0	55.812	21.517	16.903	4.215	1.553
LF-11B-39.5-42.5	0	0	0	65.501	15.385	16.200	1.457	1.457
LF-11B-42.5-45.5	0	0	0	73.047	13.802	10.547	1.497	1.107
LF-11B-45.5-48	0	0	0	66.513	16.224	12.240	1.848	3.176
LF-11B-48-63	0	0	0	58.603	17.987	13.347	4.692	5.370
LF-11C-20-32	0	0	0	72.897	15.803	7.986	1.274	2.039
LF-11C-32-36.5	0	0	0	78.500	13.750	5.417	1.417	0.917
LF-11C-36.5-39.5	0	0	0	68.283	15.354	12.929	1.684	1.751
LF-11C-39.5-42.5	0	0	0	54.649	16.000	23.169	3.325	2.857
LF-11C-42.5-45.5	0	0	0	52.034	17.077	27.825	1.959	1.105
LF-11C-45.5-48	0	0	0	61.046	16.912	18.385	2.184	1.473
LF-11C-48-63	0	0	0	68.675	17.108	8.494	1.747	3.976
LF-39A-11-29	0	0	0	84.080	8.655	2.937	0.927	3.400
LF-39A-29-34.5	0	0	0	91.803	5.801	1.009	0.126	1.261
LF-39A-34.5-39.5	0	0	0	87.993	6.272	1.792	1.523	2.419
LF-39A-39.5-44.5	0	0	0	92.118	5.583	1.314	0.246	0.739
LF-39A-44.5-49.5	0	0	0	92.118	5.793	1.709	0.000	0.380
LF-39A-49.5-56	0	0	0	72.749	5.965	3.041	2.456	15.789
LF-39A-56-73	0	0	0	84.876	6.998	3.160	2.032	2.935
LF-39B-11-29	0	0	0	84.881	5.832	2.376	2.052	4.860
LF-39B-29-34.5	0	0	0	91.037	4.599	1.715	1.169	1.481
LF-39B-34.5-39.5	0	0	0	72.086	13.614	9.892	2.840	1.567
LF-39B-39.5-44.5	0	0	0	83.768	8.513	4.540	1.589	1.589
LF-39B-44.5-49.5	0	0	0	87.889	5.190	1.961	1.499	3.460
LF-39B-49.5-56	0	0	0	82.818	5.810	2.719	2.101	6.551
LF-39B-56-73	0	0	0	48.335	4.377	4.091	4.377	38.820
LF-39C-11-29	0	0	0	92.934	3.593	1.317	0.719	1.437
LF-39C-29-34.5	0	0	0	89.591	6.134	2.045	0.929	1.301
LF-39C-34.5-39.5	0	0	0	87.824	5.561	1.534	1.534	3.547
LF-39C-39.5-44.5	0	0	0	90.173	5.491	2.119	0.963	1.252
LF-39C-44.5-49.5	0	0	0	90.871	4.668	1.452	0.830	2.178
LF-39C-49.5-56	0	0	0	91.331	4.396	1.343	1.343	1.587
LF-39C-56-73	0	0	0	79.878	6.504	2.846	2.337	8.435
LF-25A-8-25	0	0	0	59.104	13.433	7.164	6.567	13.731
LF-25A-25-30.5	0	0	0	98.965	0.690	0.167	0.073	0.105
LF-25A-30.5-36	0	0	0	98.629	0.762	0.269	0.206	0.134
LF-25A-36-42	0	0	0	98.305	0.618	0.201	0.292	0.584

Table C.4 – Measured Suspended Sediment for LFCC for 300 cfs								
Title[1]	sus bin1	sus bin2	sus bin3	sus bin4	sus bin5	sus bin6	sus bin7	sus bin8
LF-25A-42-48	0	0	0	98.919	0.584	0.185	0.097	0.214
LF-25A-48-54	0	0	0	98.996	0.579	0.164	0.184	0.077
LF-25A-54-68	0	0	0	97.550	0.960	0.305	0.474	0.711
LF-25B-8-25	0	0	0	99.026	0.409	0.218	0.155	0.191
LF-25B-25-30.5	0	0	0	98.856	0.605	0.210	0.105	0.224
LF-25B-30.5-36	0	0	0	98.689	0.692	0.218	0.209	0.191
LF-25B-36-42	0	0	0	98.784	0.687	0.190	0.190	0.148
LF-25B-42-48	0	0	0	98.677	0.637	0.274	0.242	0.169
LF-25B-48-54	0	0	0	98.798	0.446	0.237	0.182	0.337
LF-25B-54-68	0	0	0	97.909	1.166	0.400	0.258	0.267
LF-25C-8-25	0	0	0	99.229	0.555	0.102	0.045	0.068
LF-25C-25-30.5	0	0	0	98.813	0.694	0.168	0.168	0.157
LF-25C-30.5-36	0	0	0	98.869	0.792	0.142	0.089	0.107
LF-25C-36-42	0	0	0	98.583	0.887	0.196	0.138	0.196
LF-25C-42-48	0	0	0	98.658	0.765	0.188	0.165	0.224
LF-25C-48-54	0	0	0	98.875	0.577	0.202	0.125	0.221
LF-25C-54-68	0	0	0	94.313	0.976	0.500	0.818	3.393

Table C.4 – Measured Suspended Sediment for LFCC for 300 cfs								
Title[1]	Sus bin9	Sus bin10	Sus bin11	Sus bin12	Sus bin13	Sus bin14	Sus bin15	Sus bin16
LF-11A-20-32	0	0	0	0	0	0	0	0
LF-11A-32-36.5	0	0	0	0	0	0	0	0
LF-11A-36.5-39.5	0	0	0	0	0	0	0	0
LF-11A-39.5-42.5	0	0	0	0	0	0	0	0
LF-11A-42.5-45.5	0	0	0	0	0	0	0	0
LF-11A-45.5-48	0	0	0	0	0	0	0	0
LF-11A-48-63	0	0	0	0	0	0	0	0
LF-11B-20-32	0	0	0	0	0	0	0	0
LF-11B-32-36.5	0	0	0	0	0	0	0	0
LF-11B-36.5-39.5	0	0	0	0	0	0	0	0
LF-11B-39.5-42.5	0	0	0	0	0	0	0	0
LF-11B-42.5-45.5	0	0	0	0	0	0	0	0
LF-11B-45.5-48	0	0	0	0	0	0	0	0
LF-11B-48-63	0	0	0	0	0	0	0	0
LF-11C-20-32	0	0	0	0	0	0	0	0
LF-11C-32-36.5	0	0	0	0	0	0	0	0
LF-11C-36.5-39.5	0	0	0	0	0	0	0	0
LF-11C-39.5-42.5	0	0	0	0	0	0	0	0
LF-11C-42.5-45.5	0	0	0	0	0	0	0	0
LF-11C-45.5-48	0	0	0	0	0	0	0	0
LF-11C-48-63	0	0	0	0	0	0	0	0
LF-39A-11-29	0	0	0	0	0	0	0	0
LF-39A-29-34.5	0	0	0	0	0	0	0	0
LF-39A-34.5-39.5	0	0	0	0	0	0	0	0
LF-39A-39.5-44.5	0	0	0	0	0	0	0	0
LF-39A-44.5-49.5	0	0	0	0	0	0	0	0

Table C.4 – Measured Suspended Sediment for LFCC for 300 cfs								
Title[1]	Sus bin9	Sus bin10	Sus bin11	Sus bin12	Sus bin13	Sus bin14	Sus bin15	Sus bin16
LF-39A-49.5-56	0	0	0	0	0	0	0	0
LF-39A-56-73	0	0	0	0	0	0	0	0
LF-39B-11-29	0	0	0	0	0	0	0	0
LF-39B-29-34.5	0	0	0	0	0	0	0	0
LF-39B-34.5-39.5	0	0	0	0	0	0	0	0
LF-39B-39.5-44.5	0	0	0	0	0	0	0	0
LF-39B-44.5-49.5	0	0	0	0	0	0	0	0
LF-39B-49.5-56	0	0	0	0	0	0	0	0
LF-39B-56-73	0	0	0	0	0	0	0	0
LF-39C-11-29	0	0	0	0	0	0	0	0
LF-39C-29-34.5	0	0	0	0	0	0	0	0
LF-39C-34.5-39.5	0	0	0	0	0	0	0	0
LF-39C-39.5-44.5	0	0	0	0	0	0	0	0
LF-39C-44.5-49.5	0	0	0	0	0	0	0	0
LF-39C-49.5-56	0	0	0	0	0	0	0	0
LF-39C-56-73	0	0	0	0	0	0	0	0
LF-25A-8-25	0	0	0	0	0	0	0	0
LF-25A-25-30.5	0	0	0	0	0	0	0	0
LF-25A-30.5-36	0	0	0	0	0	0	0	0
LF-25A-36-42	0	0	0	0	0	0	0	0
LF-25A-42-48	0	0	0	0	0	0	0	0
LF-25A-48-54	0	0	0	0	0	0	0	0
LF-25A-54-68	0	0	0	0	0	0	0	0
LF-25B-8-25	0	0	0	0	0	0	0	0
LF-25B-25-30.5	0	0	0	0	0	0	0	0
LF-25B-30.5-36	0	0	0	0	0	0	0	0
LF-25B-36-42	0	0	0	0	0	0	0	0
LF-25B-42-48	0	0	0	0	0	0	0	0
LF-25B-48-54	0	0	0	0	0	0	0	0
LF-25B-54-68	0	0	0	0	0	0	0	0
LF-25C-8-25	0	0	0	0	0	0	0	0
LF-25C-25-30.5	0	0	0	0	0	0	0	0
LF-25C-30.5-36	0	0	0	0	0	0	0	0
LF-25C-36-42	0	0	0	0	0	0	0	0
LF-25C-42-48	0	0	0	0	0	0	0	0
LF-25C-48-54	0	0	0	0	0	0	0	0
LF-25C-54-68	0	0	0	0	0	0	0	0

Table C.5 – Measured Data Input for LFCC for 600 cfs							
Title	S_f	g (ft/s^2)	γ_w (lb/ft^3)	γ_s (lb/ft^3)	Q (cfs)	V_{avg} (ft/s)	h (ft)
LF-11A-15-34	0.0008	32.17	62.4	165	142.752	2.0839708	5.4
LF-11A-34-38	0.0008	32.17	62.4	165	93.705	3.0824013	7.6
LF-11A-38-42	0.0008	32.17	62.4	165	91.065	2.9759804	7.9
LF-11A-42-46	0.0008	32.17	62.4	165	91.155	3.0795608	8.4
LF-11A-46-50	0.0008	32.17	62.4	165	86.61	2.9063758	8.4
LF-11A-50-54	0.0008	32.17	62.4	165	56.64	2.4733624	7.7
LF-11A-54-66	0.0008	32.17	62.4	165	59.497	1.7866967	4.2
LF-11B-15-34	0.0008	32.17	62.4	165	138.661	2.0331525	7.2
LF-11B-34-38	0.0008	32.17	62.4	165	88.05	2.9448161	7.5
LF-11B-38-42	0.0008	32.17	62.4	165	89.06	2.9785953	7.4
LF-11B-42-46	0.0008	32.17	62.4	165	88.925	2.9641667	7.5
LF-11B-46-50	0.0008	32.17	62.4	165	83.11	2.8462329	7.3
LF-11B-50-54	0.0008	32.17	62.4	165	49.96	2.3566038	4.8
LF-11B-54-66	0.0008	32.17	62.4	165	57.468	1.7154627	4
LF-11C-15-34	0.0008	32.17	62.4	165	130.848	1.9825455	7.2
LF-11C-34-38	0.0008	32.17	62.4	165	91.67	3.1610345	7.5
LF-11C-38-42	0.0008	32.17	62.4	165	90.575	3.166958	7.4
LF-11C-42-46	0.0008	32.17	62.4	165	87.425	3.0568182	7.5
LF-11C-46-50	0.0008	32.17	62.4	165	75.13	2.6547703	7.3
LF-11C-50-54	0.0008	32.17	62.4	165	46.51	2.2147619	4.8
LF-11C-54-66	0.0008	32.17	62.4	165	57.111	1.715045	4
LF-25A-5-21	0.0008	32.17	62.4	165	72.107	1.164895	6
LF-25A-21-27.5	0.0008	32.17	62.4	165	31.8695	0.7027453	7.2
LF-25A-27.5-34.5	0.0008	32.17	62.4	165	67.335	1.3467	7.5
LF-25A-34.5-41.5	0.0008	32.17	62.4	165	120.76	2.2593078	7.9
LF-25A-41.5-48.5	0.0008	32.17	62.4	165	126.325	2.3834906	7.7
LF-25A-48.5-57	0.0008	32.17	62.4	165	127.5875	1.9811724	7.7
LF-25A-57-71	0.0008	32.17	62.4	165	40.966	0.8112079	4.8
LF-25B-5-21	0.0008	32.17	62.4	165	65.56	1.159328	6.1
LF-25B-21-27.5	0.0008	32.17	62.4	165	33.0745	0.739095	7
LF-25B-27.5-34.5	0.0008	32.17	62.4	165	61.1085	1.2625723	6.7
LF-25B-34.5-41.5	0.0008	32.17	62.4	165	116.9525	2.1983553	7.6
LF-25B-41.5-48.5	0.0008	32.17	62.4	165	118.92	2.2480151	7.6
LF-25B-48.5-57	0.0008	32.17	62.4	165	129.4675	2.011927	7.6
LF-25B-57-71	0.0008	32.17	62.4	165	40.906	0.8539875	4.2
LF-25C-5-21	0.0008	32.17	62.4	165	68.475	1.1346313	6.1
LF-25C-21-27.5	0.0008	32.17	62.4	165	30.24325	0.6944489	7.1
LF-25C-27.5-34.5	0.0008	32.17	62.4	165	65.85725	1.3250956	7.5
LF-25C-34.5-41.5	0.0008	32.17	62.4	165	113.9175	2.1534499	7.7
LF-25C-41.5-48.5	0.0008	32.17	62.4	165	122.0025	2.3327438	7.7
LF-25C-48.5-57	0.0008	32.17	62.4	165	127.1375	1.9818784	7.7
LF-25C-57-71	0.0008	32.17	62.4	165	45.507	0.8668	4.7
LF-39A-5-20	0.0008	32.17	62.4	165	40.164	0.9495035	4.8
LF-39A-20-28	0.0008	32.17	62.4	165	80.65	1.6033797	6.4

Table C.5 – Measured Data Input for LFCC for 600 cfs							
Title	S_f	g (ft/s^2)	γ_w (lb/ft^3)	γ_s (lb/ft^3)	Q (cfs)	V_{avg} (ft/s)	h (ft)
LF-39A-28-37	0.0008	32.17	62.4	165	139.99	2.3331667	7.1
LF-39A-37-46	0.0008	32.17	62.4	165	141.01	2.4523478	6.9
LF-39A-46-55	0.0008	32.17	62.4	165	104.02	1.9889101	5.9
LF-39A-55-62	0.0008	32.17	62.4	165	56.195	1.3639563	6.4
LF-39A-62-77	0.0008	32.17	62.4	165	40.758	0.7860752	5.4
LF-39B-5-20	0.0008	32.17	62.4	165	37.511	0.9593606	5.1
LF-39B-20-28	0.0008	32.17	62.4	165	80.53	1.5946535	6.5
LF-39B-28-37	0.0008	32.17	62.4	165	136.825	2.2615702	6.9
LF-39B-37-46	0.0008	32.17	62.4	165	130.4	2.2917399	6.8
LF-39B-46-55	0.0008	32.17	62.4	165	103.56	2.0345776	5.8
LF-39B-55-62	0.0008	32.17	62.4	165	47.715	1.1781481	6
LF-39B-62-77	0.0008	32.17	62.4	165	34.66	0.6911266	5
LF-39C-5-20	0.0008	32.17	62.4	165	38.749	0.9748176	4.8
LF-39C-20-28	0.0008	32.17	62.4	165	78.93	1.5723108	6
LF-39C-28-37	0.0008	32.17	62.4	165	129.595	2.1707705	6.7
LF-39C-37-46	0.0008	32.17	62.4	165	133.575	2.3516725	6.3
LF-39C-46-55	0.0008	32.17	62.4	165	100.955	1.9564922	5.6
LF-39C-55-62	0.0008	32.17	62.4	165	51.61	1.2618582	5.9
LF-39C-62-77	0.0008	32.17	62.4	165	36.822	0.7291485	5.4

Table C.5 – Measured Data Input for LFCC for 600 cfs							
Title	W (ft)	T (F)	dn (ft)	Cs (ppm)	d65 (mm)	d35 (mm)	ds (ft)
LF-11A-15-34	17	70	0.3	579.2	0.3	0.19	5.1
LF-11A-34-38	2	70	0.3	643.3	0.3	0.19	7.3
LF-11A-38-42	2	70	0.3	715	0.3	0.19	7.6
LF-11A-42-46	2	70	0.3	690.1	0.19	0.15	8.1
LF-11A-46-50	2	70	0.3	535.8	0.14	0.028	8.1
LF-11A-50-54	2	70	0.3	555.9	0.17	0.13	7.4
LF-11A-54-66	2	70	0.3	538.6	0.17	0.13	3.9
LF-11B-15-34	17	70	0.3	565.6	0.19	0.16	6.9
LF-11B-34-38	2	70	0.3	699.1	0.19	0.16	7.2
LF-11B-38-42	2	70	0.3	731.4	0.19	0.16	7.1
LF-11B-42-46	2	70	0.3	593.3	0.175	0.135	7.2
LF-11B-46-50	2	70	0.3	586.5	0.175	0.135	7
LF-11B-50-54	2	70	0.3	537.5	0.16	0.11	4.5
LF-11B-54-66	2	70	0.3	505.8	0.16	0.11	3.7
LF-11C-15-34	17	70	0.3	593.5	0.19	0.15	6.9
LF-11C-34-38	2	70	0.3	566.5	0.19	0.15	7.2
LF-11C-38-42	2	70	0.3	644.3	0.28	0.11	7.1
LF-11C-42-46	2	70	0.3	752.9	0.2	0.16	7.2
LF-11C-46-50	2	70	0.3	579.1	0.185	0.14	7
LF-11C-50-54	2	70	0.3	499.6	0.17	0.12	4.5
LF-11C-54-66	2	70	0.3	420.2	0.17	0.12	3.7

Table C.5 – Measured Data Input for LFCC for 600 cfs							
Title	W (ft)	T (F)	dn (ft)	Cs (ppm)	d65 (mm)	d35 (mm)	ds (ft)
LF-25A-5-21	13	70	0.3	266.3	0.37	0.32	5.7
LF-25A-21-27.5	3	70	0.3	314.3	0.37	0.32	6.9
LF-25A-27.5-34.5	3.5	70	0.3	320.8	0.37	0.32	7.2
LF-25A-34.5-41.5	3.5	70	0.3	337.9	0.38	0.31	7.6
LF-25A-41.5-48.5	3.5	70	0.3	326	0.34	0.27	7.4
LF-25A-48.5-57	3.5	70	0.3	310.2	0.35	0.28	7.4
LF-25A-57-71	5	70	0.3	274.4	0.35	0.28	4.5
LF-25B-5-21	13	70	0.3	274.9	0.38	0.28	5.8
LF-25B-21-27.5	3	70	0.3	306	0.38	0.28	6.7
LF-25B-27.5-34.5	3.5	70	0.3	316.5	0.38	0.28	6.4
LF-25B-34.5-41.5	3.5	70	0.3	332.6	0.35	0.29	7.3
LF-25B-41.5-48.5	3.5	70	0.3	307	0.36	0.3	7.3
LF-25B-48.5-57	3.5	70	0.3	311.6	0.33	0.26	7.3
LF-25B-57-71	5	70	0.3	302.3	0.33	0.26	3.9
LF-25C-5-21	13	70	0.3	271.9	0.34	0.24	5.8
LF-25C-21-27.5	3	70	0.3	294.6	0.34	0.24	6.8
LF-25C-27.5-34.5	3.5	70	0.3	303.9	0.34	0.24	7.2
LF-25C-34.5-41.5	3.5	70	0.3	307.6	0.38	0.29	7.4
LF-25C-41.5-48.5	3.5	70	0.3	306.2	0.37	0.29	7.4
LF-25C-48.5-57	3.5	70	0.3	299.1	0.32	0.23	7.4
LF-25C-57-71	5	70	0.3	277.6	0.32	0.23	4.4
LF-39A-5-20	13	70	0.3	229.2	0.22	0.17	4.5
LF-39A-20-28	4	70	0.3	219.7	0.22	0.17	6.1
LF-39A-28-37	5	70	0.3	242.2	0.35	0.28	6.8
LF-39A-37-46	5	70	0.3	244	0.3	0.2	6.6
LF-39A-46-55	5	70	0.3	244.6	0.3	0.2	5.6
LF-39A-55-62	5	70	0.3	250.4	0.3	0.2	6.1
LF-39A-62-77	4	70	0.3	243.8	0.3	0.2	5.1
LF-39B-5-20	13	70	0.3	213.7	0.3	0.2	4.8
LF-39B-20-28	4	70	0.3	230.1	0.3	0.2	6.2
LF-39B-28-37	5	70	0.3	247	0.31	0.21	6.6
LF-39B-37-46	5	70	0.3	243.3	0.35	0.27	6.5
LF-39B-46-55	4	70	0.3	219	0.3	0.2	5.5
LF-39B-55-62	3	70	0.3	224.2	0.19	0.12	5.7
LF-39B-62-77	5	70	0.3	230.8	0.19	0.12	4.7
LF-39C-5-20	13	70	0.3	210.6	0.24	0.18	4.5
LF-39C-20-28	4	70	0.3	223.5	0.24	0.18	5.7
LF-39C-28-37	5	70	0.3	262.1	0.31	0.22	6.4
LF-39C-37-46	5	70	0.3	229	0.33	0.25	6
LF-39C-46-55	4	70	0.3	213.3	0.25	0.19	5.3
LF-39C-55-62	3	70	0.3	229.3	0.21	0.08	5.6
LF-39C-62-77	5	70	0.3	202.8	0.21	0.08	5.1

Table C.6 – Measured Bed Material for LFCC for 600 cfs								
Title	bed bin1	bed bin2	bed bin3	bed bin4	bed bin5	bed bin6	bed bin7	bed bin8
LF-11A-15-34	0	0	0	97.8707	0.8492	1.1602	0.1061	0.0000
LF-11A-34-38	0	0	0	99.7647	0.1135	0.1097	0.0121	0.0000
LF-11A-38-42	0	0	0	0.1755	4.4737	50.7991	23.9096	6.5635
LF-11A-42-46	0	0	0	0.3070	6.7046	87.9882	4.9249	0.0527
LF-11A-46-50	0	0	0	46.2021	10.0175	37.4731	5.5653	0.0000
LF-11A-50-54	0	0	0	2.7324	20.7276	74.5159	1.4927	0.5229
LF-11A-54-66	0	0	0	2.7324	20.7276	74.5159	1.4927	0.5229
LF-11B-15-34	0	0	0	93.0625	2.2000	4.1693	0.5682	0.0000
LF-11B-34-38	0	0	0	98.7943	0.1866	0.9100	0.0697	0.0000
LF-11B-38-42	0	0	0	0.3871	6.1165	90.9478	2.3292	0.1140
LF-11B-42-46	0	0	0	99.0229	0.3096	0.3438	0.3170	0.0000
LF-11B-46-50	0	0	0	98.8649	0.3574	0.6565	0.1195	0.0000
LF-11B-50-54	0	0	0	3.5305	39.0228	56.5189	0.8917	0.0120
LF-11B-54-66	0	0	0	3.5305	39.0228	56.5189	0.8917	0.0120
LF-11C-15-34	0	0	0	99.4969	0.2398	0.1644	0.0989	0.0000
LF-11C-34-38	0	0	0	0.4621	7.8137	90.2745	1.2732	0.1507
LF-11C-38-42	0	0	0	32.9502	2.6820	22.4138	32.9502	0.0000
LF-11C-42-46	0	0	0	0.2597	6.6588	81.5263	8.2851	1.7832
LF-11C-46-50	0	0	0	98.9525	0.2524	0.6792	0.1159	0.0000
LF-11C-50-54	0	0	0	3.8871	19.0950	75.0427	1.7490	0.1235
LF-11C-54-66	0	0	0	3.8871	19.0950	75.0427	1.7490	0.1235
LF-25A-5-21	0	0	0	2.6907	2.3773	3.9852	84.2555	3.0022
LF-25A-21-27.5	0	0	0	2.6907	2.3773	3.9852	84.2555	3.0022
LF-25A-27.5-34.5	0	0	0	2.6907	2.3773	3.9852	84.2555	3.0022
LF-25A-34.5-41.5	0	0	0	0.4551	1.2297	12.2910	73.0589	9.7574
LF-25A-41.5-48.5	0	0	0	0.5207	11.6193	15.8404	66.6389	4.2327
LF-25A-48.5-57	0	0	0	0.4391	2.6150	16.5991	76.3530	2.8010
LF-25A-57-71	0	0	0	0.4391	2.6150	16.5991	76.3530	2.8010
LF-25B-5-21	0	0	0	4.7030	5.4005	16.3051	56.2553	8.0241
LF-25B-21-27.5	0	0	0	4.7030	5.4005	16.3051	56.2553	8.0241
LF-25B-27.5-34.5	0	0	0	4.7030	5.4005	16.3051	56.2553	8.0241
LF-25B-34.5-41.5	0	0	0	0.6087	1.5531	17.7313	71.6332	5.8851
LF-25B-41.5-48.5	0	0	0	0.2520	0.8811	13.9359	75.6045	6.6717
LF-25B-48.5-57	0	0	0	2.1238	4.9606	20.9755	68.1636	2.5839
LF-25B-57-71	0	0	0	2.1238	4.9606	20.9755	68.1636	2.5839
LF-25C-5-21	0	0	0	4.4288	4.4711	23.9283	57.5728	3.7835
LF-25C-21-27.5	0	0	0	4.4288	4.4711	23.9283	57.5728	3.7835
LF-25C-27.5-34.5	0	0	0	4.4288	4.4711	23.9283	57.5728	3.7835
LF-25C-34.5-41.5	0	0	0	0.5012	1.7872	16.6538	71.7887	6.7895
LF-25C-41.5-48.5	0	0	0	1.4450	1.3319	17.2999	72.8880	5.4365
LF-25C-48.5-57	0	0	0	9.0750	6.1082	20.2443	64.2234	0.0000
LF-25C-57-71	0	0	0	9.0750	6.1082	20.2443	64.2234	0.0000
LF-39A-5-20	0	0	0	5.1451	6.1360	58.7100	28.0241	0.5401
LF-39A-20-28	0	0	0	5.1451	6.1360	58.7100	28.0241	0.5401

Table C.6 – Measured Bed Material for LFCC for 600 cfs								
Title	bed bin1	bed bin2	bed bin3	bed bin4	bed bin5	bed bin6	bed bin7	bed bin8
LF-39A-28-37	0	0	0	0.0689	0.7688	20.5968	76.0126	2.2022
LF-39A-37-46	0	0	0	0.2694	1.5273	48.0283	48.9311	1.0917
LF-39A-46-55	0	0	0	0.5476	4.0436	43.7313	49.1576	2.2251
LF-39A-55-62	0	0	0	0.5476	4.0436	43.7313	49.1576	2.2251
LF-39A-62-77	0	0	0	0.5476	4.0436	43.7313	49.1576	2.2251
LF-39B-5-20	0	0	0	0.6416	3.9946	42.7925	50.6193	0.8422
LF-39B-20-28	0	0	0	0.6416	3.9946	42.7925	50.6193	0.8422
LF-39B-28-37	0	0	0	0.1163	1.6408	41.9620	54.8145	1.4282
LF-39B-37-46	0	0	0	0.1336	1.2071	23.9498	72.4932	2.0843
LF-39B-46-55	0	0	0	0.3734	3.3278	45.6305	48.1331	2.3073
LF-39B-55-62	0	0	0	10.6991	19.7003	52.4332	16.7899	0.3364
LF-39B-62-77	0	0	0	10.6991	19.7003	52.4332	16.7899	0.3364
LF-39C-5-20	0	0	0	0.5857	5.2355	56.2767	32.4651	1.6594
LF-39C-20-28	0	0	0	0.5857	5.2355	56.2767	32.4651	1.6594
LF-39C-28-37	0	0	0	0.6165	1.4953	41.2635	53.8494	2.0684
LF-39C-37-46	0	0	0	0.2684	1.1265	26.5673	70.3401	1.6383
LF-39C-46-55	0	0	0	0.8825	5.7478	51.6954	40.4329	1.1505
LF-39C-55-62	0	0	0	31.7164	11.7537	28.7313	27.7985	0.0000
LF-39C-62-77	0	0	0	31.7164	11.7537	28.7313	27.7985	0.0000

Table C.6 – Measured Bed Material for LFCC for 600 cfs								
Title	bed bin9	bed bin10	bed bin11	bed bin12	bed bin13	bed bin14	bed bin15	bed bin16
LF-11A-15-34	0.0000	0.0138	0.0000	0	0	0	0	0
LF-11A-34-38	0.0000	0.0000	0.0000	0	0	0	0	0
LF-11A-38-42	2.1072	0.6892	11.2822	0	0	0	0	0
LF-11A-42-46	0.0226	0.0000	0.0000	0	0	0	0	0
LF-11A-46-50	0.0000	0.7420	0.0000	0	0	0	0	0
LF-11A-50-54	0.0067	0.0017	0.0000	0	0	0	0	0
LF-11A-54-66	0.0067	0.0017	0.0000	0	0	0	0	0
LF-11B-15-34	0.0000	0.0000	0.0000	0	0	0	0	0
LF-11B-34-38	0.0000	0.0393	0.0000	0	0	0	0	0
LF-11B-38-42	0.0538	0.0516	0.0000	0	0	0	0	0
LF-11B-42-46	0.0000	0.0067	0.0000	0	0	0	0	0
LF-11B-46-50	0.0000	0.0017	0.0000	0	0	0	0	0
LF-11B-50-54	0.0000	0.0241	0.0000	0	0	0	0	0
LF-11B-54-66	0.0000	0.0241	0.0000	0	0	0	0	0
LF-11C-15-34	0.0000	0.0000	0.0000	0	0	0	0	0
LF-11C-34-38	0.0258	0.0000	0.0000	0	0	0	0	0
LF-11C-38-42	0.0000	9.0038	0.0000	0	0	0	0	0
LF-11C-42-46	0.8367	0.6502	0.0000	0	0	0	0	0
LF-11C-46-50	0.0000	0.0000	0.0000	0	0	0	0	0
LF-11C-50-54	0.1027	0.0000	0.0000	0	0	0	0	0
LF-11C-54-66	0.1027	0.0000	0.0000	0	0	0	0	0

Table C.6 – Measured Bed Material for LFCC for 600 cfs								
Title	bed bin9	bed bin10	bed bin11	bed bin12	bed bin13	bed bin14	bed bin15	bed bin16
LF-25A-5-21	1.5889	2.1002	0.0000	0	0	0	0	0
LF-25A-21-27.5	1.5889	2.1002	0.0000	0	0	0	0	0
LF-25A-27.5-34.5	1.5889	2.1002	0.0000	0	0	0	0	0
LF-25A-34.5-41.5	2.4315	0.7764	0.0000	0	0	0	0	0
LF-25A-41.5-48.5	0.8029	0.3450	0.0000	0	0	0	0	0
LF-25A-48.5-57	0.6013	0.5915	0.0000	0	0	0	0	0
LF-25A-57-71	0.6013	0.5915	0.0000	0	0	0	0	0
LF-25B-5-21	7.8555	1.4565	0.0000	0	0	0	0	0
LF-25B-21-27.5	7.8555	1.4565	0.0000	0	0	0	0	0
LF-25B-27.5-34.5	7.8555	1.4565	0.0000	0	0	0	0	0
LF-25B-34.5-41.5	1.6739	0.7559	0.1588	0	0	0	0	0
LF-25B-41.5-48.5	1.7737	0.5848	0.2963	0	0	0	0	0
LF-25B-48.5-57	0.5817	0.4670	0.1437	0	0	0	0	0
LF-25B-57-71	0.5817	0.4670	0.1437	0	0	0	0	0
LF-25C-5-21	2.1510	3.1344	0.5301	0	0	0	0	0
LF-25C-21-27.5	2.1510	3.1344	0.5301	0	0	0	0	0
LF-25C-27.5-34.5	2.1510	3.1344	0.5301	0	0	0	0	0
LF-25C-34.5-41.5	1.7332	0.5844	0.1619	0	0	0	0	0
LF-25C-41.5-48.5	0.9499	0.4446	0.2041	0	0	0	0	0
LF-25C-48.5-57	0.0000	0.3490	0.0000	0	0	0	0	0
LF-25C-57-71	0.0000	0.3490	0.0000	0	0	0	0	0
LF-39A-5-20	0.1592	0.3988	0.8868	0	0	0	0	0
LF-39A-20-28	0.1592	0.3988	0.8868	0	0	0	0	0
LF-39A-28-37	0.2386	0.1121	0.0000	0	0	0	0	0
LF-39A-37-46	0.0980	0.0542	0.0000	0	0	0	0	0
LF-39A-46-55	0.2658	0.0290	0.0000	0	0	0	0	0
LF-39A-55-62	0.2658	0.0290	0.0000	0	0	0	0	0
LF-39A-62-77	0.2658	0.0290	0.0000	0	0	0	0	0
LF-39B-5-20	0.0223	0.1146	0.9728	0	0	0	0	0
LF-39B-20-28	0.0223	0.1146	0.9728	0	0	0	0	0
LF-39B-28-37	0.0099	0.0282	0.0000	0	0	0	0	0
LF-39B-37-46	0.0821	0.0499	0.0000	0	0	0	0	0
LF-39B-46-55	0.1647	0.0632	0.0000	0	0	0	0	0
LF-39B-55-62	0.0411	0.0000	0.0000	0	0	0	0	0
LF-39B-62-77	0.0411	0.0000	0.0000	0	0	0	0	0
LF-39C-5-20	0.3703	0.2990	3.1081	0	0	0	0	0
LF-39C-20-28	0.3703	0.2990	3.1081	0	0	0	0	0
LF-39C-28-37	0.6021	0.1049	0.0000	0	0	0	0	0
LF-39C-37-46	0.0203	0.0390	0.0000	0	0	0	0	0
LF-39C-46-55	0.0454	0.0454	0.0000	0	0	0	0	0
LF-39C-55-62	0.0000	0.0000	0.0000	0	0	0	0	0
LF-39C-62-77	0.0000	0.0000	0.0000	0	0	0	0	0

Table C.7– Measured Suspended Sediment for LFCC for 600 cfs								
Title	sus bin1	sus bin2	sus bin3	sus bin4	sus bin5	sus bin6	sus bin7	sus bin8
LF-11A-15-34	0	0	0	63.3466	26.7596	9.16335	0.36521	0.36521
LF-11A-34-38	0	0	0	57.9192	28.7148	12.6561	0.39168	0.31824
LF-11A-38-42	0	0	0	53.8375	14.3656	30.8794	0.62654	0.29089
LF-11A-42-46	0	0	0	58.0495	27.0573	13.4123	0.8462	0.63465
LF-11A-46-50	0	0	0	61.809	23.0438	12.0962	1.50754	1.54343
LF-11A-50-54	0	0	0	64.4663	24.3533	9.27743	0.53524	1.36783
LF-11A-54-66	0	0	0	74.1379	20.3249	4.90716	0.33156	0.29841
LF-11B-15-34	0	0	0	68.5003	21.5128	7.85855	1.11329	1.01506
LF-11B-34-38	0	0	0	55.7854	28.1481	14.8914	0.79183	0.38314
LF-11B-38-42	0	0	0	54.8333	28.4721	15.7832	0.62365	0.28784
LF-11B-42-46	0	0	0	44.1925	36.1324	18.0509	1.01134	0.61293
LF-11B-46-50	0	0	0	64.2447	24.2511	10.1338	0.57361	0.79669
LF-11B-50-54	0	0	0	67.2868	23.0388	8.52713	0.46512	0.68217
LF-11B-54-66	0	0	0	72.5475	21.2548	5.28517	0.22814	0.68441
LF-11C-15-34	0	0	0	59.0784	27.4415	11.6231	0.8597	0.99725
LF-11C-34-38	0	0	0	61.6816	26.0591	10.6226	0.99487	0.64185
LF-11C-38-42	0	0	0	53.944	28.5242	16.3359	0.89059	0.30534
LF-11C-42-46	0	0	0	48.7255	28.3606	21.0089	0.99276	0.91226
LF-11C-46-50	0	0	0	57.5561	27.1547	13.0165	0.76741	1.50531
LF-11C-50-54	0	0	0	66.405	22.292	10.2826	0.39246	0.62794
LF-11C-54-66	0	0	0	75.6731	16.6346	6.58654	0.67308	0.43269
LF-25A-5-21	0	0	0	91.4027	7.05882	0.95023	0.40724	0.181
LF-25A-21-27.5	0	0	0	87.3807	9.80912	1.64369	0.63627	0.53022
LF-25A-27.5-34.5	0	0	0	85.2234	11.3402	1.91458	0.88365	0.63819
LF-25A-34.5-41.5	0	0	0	83.2575	13.1512	2.17501	0.91047	0.50582
LF-25A-41.5-48.5	0	0	0	83.0913	11.8501	3.32553	1.03044	0.70258
LF-25A-48.5-57	0	0	0	84.6285	11.9556	2.30572	0.89667	0.21349
LF-25A-57-71	0	0	0	88.5774	8.05886	1.96216	0.56062	0.84093
LF-25B-5-21	0	0	0	90.0929	7.01754	1.39319	0.77399	0.72239
LF-25B-21-27.5	0	0	0	87.5203	9.50837	1.89087	0.4322	0.6483
LF-25B-27.5-34.5	0	0	0	83.2418	12.0879	2.97619	0.54945	1.14469
LF-25B-34.5-41.5	0	0	0	80.6701	14.2612	3.00687	1.03093	1.03093
LF-25B-41.5-48.5	0	0	0	82.9103	13.2403	2.96108	0.71912	0.1692
LF-25B-48.5-57	0	0	0	88.033	9.99541	1.55892	0.2751	0.13755
LF-25B-57-71	0	0	0	88.0562	9.36768	1.52225	0.46838	0.58548
LF-25C-5-21	0	0	0	88.254	9.62963	1.16402	0.5291	0.42328
LF-25C-21-27.5	0	0	0	85.8323	11.5702	1.71192	0.59032	0.29516
LF-25C-27.5-34.5	0	0	0	80.7856	13.3758	2.91932	1.00849	1.91083
LF-25C-34.5-41.5	0	0	0	82.7915	13.8708	2.03728	0.43346	0.86693
LF-25C-41.5-48.5	0	0	0	81.9058	14.8822	2.35546	0.58887	0.26767
LF-25C-48.5-57	0	0	0	83.7364	13.1342	2.13371	0.42674	0.56899
LF-25C-57-71	0	0	0	85.9446	11.2846	1.46096	0.55416	0.75567

Table C.7– Measured Suspended Sediment for LFCC for 600 cfs

Title	sus bin1	sus bin2	sus bin3	sus bin4	sus bin5	sus bin6	sus bin7	sus bin8
LF-39A-5-20	0	0	0	92.1848	0	7.01654	0.39932	0.39932
LF-39A-20-28	0	0	0	91.2485	0.23337	6.76779	0.8168	0.93349
LF-39A-28-37	0	0	0	87.0968	9.16129	3.16129	0.58065	0
LF-39A-37-46	0	0	0	86.6397	9.7166	2.63158	0.65789	0.35425
LF-39A-46-55	0	0	0	90.6077	4.80663	3.25967	0.88398	0.44199
LF-39A-55-62	0	0	0	82.9493	5.83717	2.20174	2.40655	6.60522
LF-39A-62-77	0	0	0	86.6377	5.65569	3.48042	1.67806	2.54817
LF-39B-5-20	0	0	0	90.3941	5.54187	2.0936	0.98522	0.98522
LF-39B-20-28	0	0	0	89.5096	6.20732	1.48976	1.36561	1.42768
LF-39B-28-37	0	0	0	88.1864	7.87576	2.44038	0.88741	0.61009
LF-39B-37-46	0	0	0	86.9659	7.67983	3.35316	0.91942	1.08167
LF-39B-46-55	0	0	0	93.8356	4.56621	0.91324	0.39954	0.28539
LF-39B-55-62	0	0	0	93.8967	4.77308	0.93897	0.15649	0.23474
LF-39B-62-77	0	0	0	92.5227	5.73026	1.04822	0.27952	0.41929
LF-39C-5-20	0	0	0	93.896	5.50113	0.60286	0	0
LF-39C-20-28	0	0	0	92.7441	6.00109	0.76378	0.16367	0.32733
LF-39C-28-37	0	0	0	85.896	9.19075	2.54335	0.98266	1.38728
LF-39C-37-46	0	0	0	90.1266	7.59494	1.4557	0.37975	0.44304
LF-39C-46-55	0	0	0	92.3295	6.32102	0.85227	0.35511	0.14205
LF-39C-55-62	0	0	0	92.3077	5.86836	1.03093	0.1586	0.63442
LF-39C-62-77	0	0	0	95.8398	3.46687	0.38521	0.30817	0

Table C.7 – Measured Suspended Sediment for LFCC for 600 cfs

Title	sus bin9	sus bin10	sus bin11	sus bin12	sus bin13	sus bin14	sus bin15	sus bin16
LF-11A-15-34	0	0	0	0	0	0	0	0
LF-11A-34-38	0	0	0	0	0	0	0	0
LF-11A-38-42	0	0	0	0	0	0	0	0
LF-11A-42-46	0	0	0	0	0	0	0	0
LF-11A-46-50	0	0	0	0	0	0	0	0
LF-11A-50-54	0	0	0	0	0	0	0	0
LF-11A-54-66	0	0	0	0	0	0	0	0
LF-11B-15-34	0	0	0	0	0	0	0	0
LF-11B-34-38	0	0	0	0	0	0	0	0
LF-11B-38-42	0	0	0	0	0	0	0	0
LF-11B-42-46	0	0	0	0	0	0	0	0
LF-11B-46-50	0	0	0	0	0	0	0	0
LF-11B-50-54	0	0	0	0	0	0	0	0
LF-11B-54-66	0	0	0	0	0	0	0	0
LF-11C-15-34	0	0	0	0	0	0	0	0
LF-11C-34-38	0	0	0	0	0	0	0	0
LF-11C-38-42	0	0	0	0	0	0	0	0
LF-11C-42-46	0	0	0	0	0	0	0	0

Table C.7 – Measured Suspended Sediment for LFCC for 600 cfs								
Title	sus bin9	sus bin10	sus bin11	sus bin12	sus bin13	sus bin14	sus bin15	sus bin16
LF-11C-46-50	0	0	0	0	0	0	0	0
LF-11C-50-54	0	0	0	0	0	0	0	0
LF-11C-54-66	0	0	0	0	0	0	0	0
LF-25A-5-21	0	0	0	0	0	0	0	0
LF-25A-21-27.5	0	0	0	0	0	0	0	0
LF-25A-27.5-34.5	0	0	0	0	0	0	0	0
LF-25A-34.5-41.5	0	0	0	0	0	0	0	0
LF-25A-41.5-48.5	0	0	0	0	0	0	0	0
LF-25A-48.5-57	0	0	0	0	0	0	0	0
LF-25A-57-71	0	0	0	0	0	0	0	0
LF-25B-5-21	0	0	0	0	0	0	0	0
LF-25B-21-27.5	0	0	0	0	0	0	0	0
LF-25B-27.5-34.5	0	0	0	0	0	0	0	0
LF-25B-34.5-41.5	0	0	0	0	0	0	0	0
LF-25B-41.5-48.5	0	0	0	0	0	0	0	0
LF-25B-48.5-57	0	0	0	0	0	0	0	0
LF-25B-57-71	0	0	0	0	0	0	0	0
LF-25C-5-21	0	0	0	0	0	0	0	0
LF-25C-21-27.5	0	0	0	0	0	0	0	0
LF-25C-27.5-34.5	0	0	0	0	0	0	0	0
LF-25C-34.5-41.5	0	0	0	0	0	0	0	0
LF-25C-41.5-48.5	0	0	0	0	0	0	0	0
LF-25C-48.5-57	0	0	0	0	0	0	0	0
LF-25C-57-71	0	0	0	0	0	0	0	0
LF-39A-5-20	0	0	0	0	0	0	0	0
LF-39A-20-28	0	0	0	0	0	0	0	0
LF-39A-28-37	0	0	0	0	0	0	0	0
LF-39A-37-46	0	0	0	0	0	0	0	0
LF-39A-46-55	0	0	0	0	0	0	0	0
LF-39A-55-62	0	0	0	0	0	0	0	0
LF-39A-62-77	0	0	0	0	0	0	0	0
LF-39B-5-20	0	0	0	0	0	0	0	0
LF-39B-20-28	0	0	0	0	0	0	0	0
LF-39B-28-37	0	0	0	0	0	0	0	0
LF-39B-37-46	0	0	0	0	0	0	0	0
LF-39B-46-55	0	0	0	0	0	0	0	0
LF-39B-55-62	0	0	0	0	0	0	0	0
LF-39B-62-77	0	0	0	0	0	0	0	0
LF-39C-5-20	0	0	0	0	0	0	0	0
LF-39C-20-28	0	0	0	0	0	0	0	0
LF-39C-28-37	0	0	0	0	0	0	0	0
LF-39C-37-46	0	0	0	0	0	0	0	0
LF-39C-46-55	0	0	0	0	0	0	0	0
LF-39C-55-62	0	0	0	0	0	0	0	0
LF-39C-62-77	0	0	0	0	0	0	0	0

Table C.8– Method D Input Data at 300 cfs (Cross Section Average)

Title	Date	Time	S_energy	g (ft/s2)	gamma_w	gamma_s	Q (cfs)	Vavg (ft/s)	h (ft)	W (ft)	T (F)	dn (ft)	Cs (ppm)	d65 (mm)	d35 (mm)	ds (ft)
LF-11A	6/8/2001	1750	0.0008	32.17	62.4	165	280.16	1.82	3.566279	43	72	0.3	394.6028	0.21	0.17	3.566279
LF-11B	6/8/2001	1130	0.0008	32.17	62.4	165	272.743	1.9	3.32907	43	72	0.3	288.637	0.2	0.14	3.32907
LF-11C	6/8/2001	1600	0.0008	32.17	62.4	165	262.108	1.73	3.50814	43	72	0.3	253.3901	0.19	0.13	3.50814
LF-39A	6/9/2001	1712	0.0008	32.17	62.4	165	286.6713	1.31	3.506452	62	72	0.3	168.9171	0.2	0.07	3.506452
LF-39B	6/9/2001	1450	0.0008	32.17	62.4	165	277.4	1.29	3.459677	62	73	0.3	163.0703	0.2	0.097	3.459677
LF-39C	6/9/2001	1030	0.0008	32.17	62.4	165	289.9766	1.29	3.614516	62	72	0.3	171.5449	0.19	0.07	3.614516
LF-25A	6/11/2001	2000	0.0008	32.17	62.4	165	280.7	1.04	4.498333	60	73	0.3	1570.35	0.29	0.14	4.498333
LF-25B	6/11/2001	1840	0.0008	32.17	62.4	165	272.4	1.02	4.44	60	73	0.3	1235.898	0.29	0.15	4.44
LF-25C	6/11/2001	1445	0.0008	32.17	62.4	165	287.3	1.06	4.496667	60	73	0.3	1588.369	0.3	0.19	4.496667
LF-25D	6/11/2001	1445	0.0008	32.17	62.4	165	287.3	1.06	4.496667	60	73	0.2	1591.658	0.3	0.19	4.496667

Title	susbin1	susbin2	susbin3	susbin4	susbin5	susbin6	susbin7	susbin8	susbin9	susbin10	susbin11	susbin12	susbin13	susbin14	susbin15	susbin16
LF-11A	0	0	0	61.98548	18.63287	14.47858	1.822142	3.080921	0	0	0	0	0	0	0	0
LF-11B	0	0	0	62.47038	18.46869	13.351	2.755246	2.95468	0	0	0	0	0	0	0	0
LF-11C	0	0	0	68.27096	16.17925	11.2873	1.726361	2.536128	0	0	0	0	0	0	0	0
LF-39A	0	0	0	88.08846	5.09917	1.896628	1.341098	3.574639	0	0	0	0	0	0	0	0
LF-39B	0	0	0	85.40748	6.994761	2.515715	1.23768	3.844365	0	0	0	0	0	0	0	0
LF-39C	0	0	0	74.31122	6.113149	3.570827	2.597933	13.40688	0	0	0	0	0	0	0	0
LF-25A	0	0	0	97.85374	0.744388	0.232729	0.270003	0.899143	0	0	0	0	0	0	0	0
LF-25B	0	0	0	87.24264	4.341181	2.196028	2.054215	4.165931	0	0	0	0	0	0	0	0
LF-25C	0	0	0	98.63717	0.683914	0.264742	0.194307	0.219863	0	0	0	0	0	0	0	0
LF-25D	0	0	0	98.60402	0.660678	0.305597	0.189665	0.24004	0	0	0	0	0	0	0	0

Title	bedbin1	bedbin2	bedbin3	bedbin4	bedbin5	bedbin6	bedbin7	bedbin8	bedbin9	bedbin10	bedbin11	bedbin12	bedbin13	bedbin14	bedbin15	bedbin16
LF-11A	0	0	0	1.059023	7.477046	63.88523	13.15085	5.377413	9.025177	0.025264	0	0	0	0	0	0
LF-11B	0	0	0	1.219742	9.440556	81.72018	6.38381	0.602527	0.587024	0.046159	0	0	0	0	0	0
LF-11C	0	0	0	16.40109	6.730753	67.47356	9.021013	0.143785	0.068504	0.150288	0.011012	0	0	0	0	0
LF-39A	0	0	0	15.13867	10.70578	30.98507	41.36466	1.58582	0.15877	0.061224	0	0	0	0	0	0
LF-39B	0	0	0	9.240827	14.51125	33.66777	39.55603	2.299813	0.681807	0.0425	0	0	0	0	0	0
LF-39C	0	0	0	5.523592	11.18052	38.14669	41.67428	2.527585	0.797284	0.150048	0	0	0	0	0	0
LF-25A	0	0	0	30.36706	23.82262	16.23917	26.31592	2.229413	0.485172	0.410455	0.130195	0	0	0	0	0
LF-25B	0	0	0	21.23992	22.33962	30.68552	22.40364	1.682803	0.814131	0.82634	0.00802	0	0	0	0	0
LF-25C	0	0	0	32.23311	18.39023	25.198	21.45432	1.562649	0.546261	0.351137	0.264287	0	0	0	0	0
LF-25D	0	0	0	32.23311	18.39023	25.198	21.45432	1.562649	0.546261	0.351137	0.264287	0	0	0	0	0

Table C.9– Method D Input Data at 600 cfs (Cross Section Average)

Title	Date	Time	S_energy	g (ft/s2)	gamma_w	gamma_s	Q (cfs)	Vavg (ft/s)	h (ft)	W (ft)	T (F)	dn (ft)	Cs (ppm)	d65 (mm)	d35 (mm)	ds (ft)
LF-11A	5/27/2001	1130	0.0008	32.17	62.4	165	621	2.53	4.803922	51	70	0.3	588.7935	0.082	0.001	4.803922
LF-11B	5/27/2001	1620	0.0008	32.17	62.4	165	595.2	2.46	4.743137	51	70	0.3	576.59	0.016	0.0005	4.743137
LF-11C	5/27/2001	2200	0.0008	32.17	62.4	165	579.3	2.47	4.696	50	70	0.3	558.5942	0.1	0.0005	4.696
LF-25A	5/28/2001	1138	0.0008	32.17	62.4	165	587	1.55	5.742424	66	70	0.3	302.4286	0.39	0.28	5.742424
LF-25B	5/28/2001	1710	0.0008	32.17	62.4	165	566	1.54	5.575758	66	70	0.3	298.1038	0.39	0.29	5.575758
LF-25C	5/29/2001	1045	0.0008	32.17	62.4	165	573	1.53	5.681818	66	70	0.3	289.6882	0.37	0.26	5.681818
LF-39A	5/29/2001	1530	0.0008	32.17	62.4	165	603	1.7	4.930556	72	70	0.3	238.6293	0.31	0.2	4.930556
LF-39B	5/30/2001	920	0.0008	32.17	62.4	165	571	1.64	4.847222	72	70	0.3	228.8677	0.3	0.19	4.847222
LF-39C	5/30/2001	1500	0.0008	32.17	62.4	165	570	1.63	4.847222	72	70	0.3	221.3929	0.302	0.2	4.847222

Title	susbin1	susbin2	susbin3	susbin4	susbin5	susbin6	susbin7	susbin8	susbin9	susbin10	susbin11	susbin12	susbin13	susbin14	susbin15	susbin16
LF-11A	0	0	0	64.26602	23.97003	10.71128	0.520519	0.532156	0	0	0	0	0	0	0	0
LF-11B	0	0	0	65.04799	23.9994	9.456475	0.740243	0.755886	0	0	0	0	0	0	0	0
LF-11C	0	0	0	62.42776	24.52091	11.46948	0.795363	0.786488	0	0	0	0	0	0	0	0
LF-25A	0	0	0	86.6544	10.1109	1.996257	0.60887	0.629574	0	0	0	0	0	0	0	0
LF-25B	0	0	0	87.13409	9.780879	1.891853	0.695362	0.49782	0	0	0	0	0	0	0	0
LF-25C	0	0	0	84.89905	12.0274	1.811003	0.574302	0.688253	0	0	0	0	0	0	0	0
LF-39A	0	0	0	88.50095	4.732266	4.28447	1.022828	1.459484	0	0	0	0	0	0	0	0
LF-39B	0	0	0	90.78813	6.036379	1.751942	0.701192	0.72236	0	0	0	0	0	0	0	0
LF-39C	0	0	0	92.40001	5.948067	0.993351	0.309115	0.349461	0	0	0	0	0	0	0	0

Title	bedbin1	bedbin2	bedbin3	bedbin4	bedbin5	bedbin6	bedbin7	bedbin8	bedbin9	bedbin10	bedbin11	bedbin12	bedbin13	bedbin14	bedbin15	bedbin16
LF-11A	0	0	0	62.98128	4.725185	26.29713	3.734206	0.732215	0.219134	0.153699	1.157148	0	0	0	0	0
LF-11B	0	0	0	62.47403	3.860595	27.76589	4.599316	0.211016	0.098993	0.990156	0	0	0	0	0	0
LF-11C	0	0	0	76.16891	5.788999	17.35189	0.659091	0.012927	0.005515	0.012669	0	0	0	0	0	0
LF-25A	0	0	0	1.932134	3.288429	17.42705	67.92684	5.628128	2.849713	0.79832	0.149385	0	0	0	0	0
LF-25B	0	0	0	0.996534	4.366506	12.40369	75.14146	4.839145	1.317771	0.934898	0	0	0	0	0	0
LF-25C	0	0	0	4.127557	3.561038	19.56784	66.49647	3.798881	1.147085	1.088499	0.212637	0	0	0	0	0
LF-39A	0	0	0	1.403807	3.032705	42.31108	51.17441	1.542627	0.191294	0.141387	0.202691	0	0	0	0	0
LF-39B	0	0	0	6.647776	4.871825	40.30268	45.92305	1.333888	0.216627	0.097685	0.606468	0	0	0	0	0
LF-39C	0	0	0	2.331426	5.816733	40.83965	49.31645	1.394959	0.060679	0.05029	0.18981	0	0	0	0	0

APPENDIX D – Method A Output Data on LFCC

The highlighted locations indicated that the vertical is located in the rip rap section. A highlighted sand load indicates that an error occurred and the suspended sediment equation was used. The total sand loads for those sections were determined based on the % sand.

Table D.1 – BORAMEP Method A Output 300 cfs

***		Discharge	Conc	Suspended	d65	d35	Temp	Total Load	Total Sand	CS total	CS tot sand	%sand
Location	Date	(cfs)	(PPM)	Sample (tons/day)	(mm)	(mm)	F	(tons/day)	(>0.625mm) (tons/day)	tons/day	tons/day	
LF-11A-20-32	6/8/2001	38.098	354.5	36.46154	0.9	0.34	72	41.747112	14.60800762			31.944444
LF-11A-32-36.5		51.5175	443.1					61.566424	27.42267503			44.541608
LF-11A-36.5-39.5	6/8/2001	35.7575	421.5	40.68943	0.18	0.14	72	45.584928	18.90709448			37.100949
LF-11A-39.5-42.5	6/8/2001	35.265	451.7	43.00811	0.16	0.12	72	57.620693	34.0044684			47.207084
LF-11A-42.5-45.5	6/8/2001	32.2025	411.7	35.79761	0.18	0.14	72	43.027961	20.61476988			41.70778
LF-11A-45.5-48	6/8/2001	26.3675	391.4	27.86525	0.21	0.15	72	32.309856	13.18283836			36.020151
LF-11A-48-63	6/8/2001	53.535	392.5	56.73083	0.2	0.15	72	69.878542	23.71270173	351.7355158	152.45256	38.850387
LF-11B-20-32		33.168	274.8					24.577556	8.760457634			35.644136
LF-11B-32-36.5	6/8/2001	46.11	296.7	36.93411	0.19	0.15	72	42.293346	18.14305242			36.543606
LF-11B-36.5-39.5		32.465	322					28.192538	12.45774967			44.18811
LF-11B-39.5-42.5		32.55	290.8					25.531666	8.808127289			34.498834
LF-11B-42.5-45.5	6/8/2001	34.5975	256	23.91379	0.18	0.15	72	28.457298	9.185573729			26.953125
LF-11B-45.5-48		26.8075	298.6					21.589327	7.229682232			33.487298
LF-11B-48-63	6/8/2001	56.41	295.1	44.94228	0.21	0.16	72	49.722174	19.31214733	220.3639054	83.89679	41.397289
LF-11C-20-32		35.127	245.2					23.229464	6.295835914			27.102804
LF-11C-32-36.5	6/8/2001	49.1125	237.6	31.5098	0.19	0.15	72	41.436731	9.7160831			21.5
LF-11C-36.5-39.5	6/8/2001	35.6	203.4	19.55318	0.19	0.15	72	24.936872	9.086511452			31.717172
LF-11C-39.5-42.5	6/8/2001	35.2575	291.7	27.76528	0.18	0.14	72	33.315034	16.36719633			45.350649
LF-11C-42.5-45.5	6/8/2001	35.53	299.4	28.7216	0.21	0.16	72	33.079433	16.36142065			47.965846
LF-11C-45.5-48	6/8/2001	28.845	267.9	20.86376	0.22	0.16	72	24.480083	9.85964463			38.953784
LF-11C-48-63	6/8/2001	60.688	255.4	41.84671	0.22	0.16	72	48.279187	16.83294894	228.7568032	84.519641	31.325301
LF-25A-8-25		34.183	60.36					5.5644839	0.885845202			15.919629
LF-25A-25-30.5		8.0585	1805					39.229883	3.215564151			8.1967213
LF-25A-30.5-36	6/11/2001	41.1055	1690	187.6149	0.32	0.21	73	191.80267	2.716088038			12.007168
LF-25A-36-42		56.59	1734					264.67078	20.86075098			7.8817734
LF-25A-42-48	6/11/2001	60.045	1643	266.3721	0.35	0.28	73	377.33874	3.977045972			7.8822412
LF-25A-48-54	6/11/2001	54.32	1670	244.9289	0.3	0.19	73	255.37179	3.396734774			27.251462
LF-25A-54-68		33.032	1687					150.28828	22.7298297	1284.266615	57.781859	15.124153
LF-25B-8-25		26.159	1548					109.21012	16.51124951			15.11879
LF-25B-25-30.5		9.1135	1584					38.940908	3.490416534			8.9633671

Table D.1 – BORAMEP Method A Output 300 cfs

***		Discharge	Conc	Suspended	d65	d35	Temp	Total Load	Total Sand	CS total	CS tot sand	%sand
Location	Date	(cfs)	(PPM)	Sample (tons/day)	(mm)	(mm)	F	(tons/day)	(>0.625mm) (tons/day)	tons/day	tons/day	
LF-25B-30.5-36	6/11/2001	32.8295	1678	148.6981	0.26	0.15	73	157.87686	1.983980302			27.91381
LF-25B-36-42	6/11/2001	57.92	1675	261.8671	0.17	0.11	73	366.76531	4.703663668			16.231555
LF-25B-42-48	6/11/2001	62.15	1599	268.4014	0.33	0.26	73	279.56133	4.141526031			12.110727
LF-25B-48-54		55.425	1592					237.94689	40.88333431			17.181706
LF-25B-54-68		28.853	1561					121.4428	62.74351832	1311.744212	134.45769	51.665081
LF-25C-8-25		34.744	1590					148.94186	10.52403581			7.0658683
LF-25C-25-30.5		10.898	1624					47.719784	4.967115042			10.408922
LF-25C-30.5-36	6/11/2001	34.056	1539	141.4915	0.26	0.14	73	145.14704	1.701623876			12.176414
LF-25C-36-42		56.975	1578					242.46789	23.82632411			9.8265896
LF-25C-42-48	6/11/2001	58.14	1517	238.1581	0.36	0.28	73	289.45322	4.164613657			9.1286307
LF-25C-48-54		54.41	1529					224.35758	19.44980262			8.6691087
LF-25C-54-68		31.478	1576					133.77121	26.91737675	1231.858583	91.550892	20.121951
LF-39A-11-29		51.6076	132					18.377429	7.51554566			40.895522
LF-39A-29-34.5		43.11	149.6					17.395553	0.180010424			1.0348072
LF-39A-34.5-39.5		40.5525	169.1					18.49272	0.253597393			1.3713364
LF-39A-39.5-44.5	6/9/2001	42.91	169.2	19.59914	0.08	0.033	72	38.645414	4.051568274			1.6951508
LF-39A-44.5-49.5	6/9/2001	36.2025	184.7	18.05743	0.24	0.17	72	24.588991	2.352252595			1.0809232
LF-39A-49.5-56		38.005	178.1					18.256962	0.183380726			1.0044427
LF-39A-56-73		37.589	184.6					18.711825	0.458447111	154.4688931	14.994802	2.4500395
LF-39B-11-29		54.871	151.8					22.463991	0.218692299			0.9735238
LF-39B-29-34.5	6/9/2001	41.595	171.1	19.2119	0.31	0.22	73	20.412793	2.000701238			1.1439842
LF-39B-34.5-39.5	6/9/2001	39.4975	162.1	17.28298	0.32	0.23	73	25.779383	8.210871218			1.3105206
LF-39B-39.5-44.5	6/9/2001	39.055	151.9	16.01726	0.1	0.064	73	21.798154	4.635945611			1.2155163
LF-39B-44.5-49.5		34.9575	157.6					14.861398	0.1966174			1.3230074
LF-39B-49.5-56		36.385	158.6					15.565519	0.187058318			1.201748
LF-39B-56-73		31.026	210.2					17.5882	0.367822994	138.4694396	15.817709	2.0913055
LF-39C-11-29		55.6503	163.7					24.572351	0.189403745			0.7708003
LF-39C-29-34.5	6/9/2001	44.2025	163	19.45714	0.34	0.27	72	33.404032	3.905032958			1.1870101
LF-39C-34.5-39.5	6/9/2001	42.485	168.2	19.2971	0.32	0.22	72	20.933164	2.676202643			1.1305973
LF-39C-39.5-44.5	6/9/2001	40.08	170.2	18.41446	0.14	0.088	72	23.909522	3.452330585			1.417214
LF-39C-44.5-49.5	6/9/2001	34.7925	166.2	15.61343	0.29	0.2	72	24.527804	2.125925609			1.3418079
LF-39C-49.5-56	6/9/2001	37.0205	163.8	16.37269	0.28	0.19	72	20.153375	1.744937062			1.1253246
LF-39C-56-73		32.4405	178.9					15.652469	0.890169684	163.1527161	14.984002	5.6870881

Table D.2 – BORAMEP Method A Output 600 cfs

***		Q	C	Suspended	d65	d35	Temp	Total Load	Total Sand	CS total	total sand	%sand
Location	Date	(cfs)	(PPM)	Sample (tons/day)	(mm)	(mm)	F	(tons/day)	(>0.625mm) (tons/day)	tons/day		
LF-11A-15-34	5/27/2001	142.752	579.2	223.2531	0.3	0.19	70	229.161791	85.82107726			36.653
LF-11A-34-38		93.705	643.3					162.571344	68.41129486			42.081
LF-11A-38-42	5/27/2001	91.065	715	175.8108	0.3	0.19	70	200.960722	104.3270706			46.162
LF-11A-42-46	5/27/2001	91.155	690.1	169.8397	0.19	0.15	70	201.284343	85.04555834			41.95
LF-11A-46-50	5/27/2001	86.61	535.8	125.288	0.14	0.028	70	157.635426	68.93035578			38.191
LF-11A-50-54		56.64	555.9					84.9097636	30.1716228			35.534
LF-11A-54-66		59.497	538.6					86.4174153	22.34933154	1122.9408	465.0563	25.862
LF-11B-15-34	5/27/2001	138.661	565.6	211.7353	0.19	0.16	70	230.089893	75.32023954			31.5
LF-11B-34-38		88.05	699.1					166.010667	73.40088487			44.215
LF-11B-38-42		89.06	731.4					175.672032	79.3452713			45.167
LF-11B-42-46		88.925	593.3					142.279114	79.4024722			55.808
LF-11B-46-50	5/27/2001	83.11	586.5	131.6183	0.175	0.135	70	133.07597	47.89497002			35.755
LF-11B-50-54	5/27/2001	49.96	537.5	72.50445	0.16	0.11	70	96.6579726	35.89127945			32.713
LF-11B-54-66	5/27/2001	57.468	505.8	78.47697	0.16	0.11	70	91.8573622	27.46801898	1035.64301	418.7231	27.452
LF-11C-15-34		130.848	593.5					209.424895	85.70000842			40.922
LF-11C-34-38	5/27/2001	91.67	566.5	140.2251	0.19	0.15	70	166.002596	66.53267119			38.318
LF-11C-38-42	5/27/2001	90.575	644.3	157.5559	0.28	0.11	70	184.104612	97.8828641			46.056
LF-11C-42-46	5/27/2001	87.425	752.9	177.7271	0.2	0.16	70	199.195732	109.2547984			51.274
LF-11C-46-50		75.13	579.1					117.344792	49.80572922			42.444
LF-11C-50-54		46.51	499.6					62.6669389	21.05294337			33.595
LF-11C-54-66	5/27/2001	57.111	420.2	64.79503	0.17	0.12	70	73.1886198	19.52053283	1011.92819	449.7495	24.327
LF-25A-5-21		72.107	266.3					51.7791006	4.451596886			8.5973
LF-25A-21-27.5		31.8695	314.3					27.0164687	3.409289263			12.619
LF-25A-27.5-34.5		67.335	320.8					58.253371	8.607886446			14.777
LF-25A-34.5-41.5	5/28/2001	120.76	337.9	110.1889	0.38	0.31	70	116.158936	21.95664308			16.743
LF-25A-41.5-48.5	5/28/2001	126.325	326	111.1756	0.34	0.27	70	118.142471	22.70860282			16.909
LF-25A-48.5-57	5/28/2001	127.5875	310.2	106.8592	0.35	0.28	70	112.520489	19.07149949			15.371
LF-25A-57-71		40.966	274.4					30.3184563	3.463145319	514.189294	83.66866	11.423
LF-25B-5-21		65.56	274.9					48.6033825	4.815195793			9.9071
LF-25B-21-27.5		33.0745	306					27.2902319	3.40575017			12.48
LF-25B-27.5-34.5		61.1085	316.5					52.1636607	8.741712363			16.758
LF-25B-34.5-41.5	5/28/2001	116.9525	332.6	105.0167	0.35	0.29	70	114.253726	24.62333154			19.33
LF-25B-41.5-48.5	5/28/2001	118.92	307	98.57696	0.36	0.3	70	103.216002	19.95883796			17.09

Table D.2 – BORAMEP Method A Output 600 cfs

***		Q	C	Suspended	d65	d35	Temp	Total Load	Total Sand	CS total	total sand	%sand
Location	Date	(cfs)	(PPM)	Sample (tons/day)	(mm)	(mm)	F	(tons/day)	(>0.625mm) (tons/day)	tons/day		
LF-25B-48.5-57	5/28/2001	129.4675	311.6	108.9136	0.33	0.26	70	118.751897	16.44068618			11.967
LF-25B-57-71		40.906	302.3					33.3495	3.983195549	497.628399	81.96871	11.944
LF-25C-5-21		68.475	271.9					50.219448	5.898792304			11.746
LF-25C-21-27.5		30.24325	294.6					24.0290674	3.404354291			14.168
LF-25C-27.5-34.5		65.85725	303.9					53.9704072	10.3701101			19.214
LF-25C-34.5-41.5	5/29/2001	113.9175	307.6	94.61076	0.38	0.29	70	103.481868	20.0564992			17.208
LF-25C-41.5-48.5	5/29/2001	122.0025	306.2	100.8741	0.37	0.29	70	108.793112	22.87174075			18.094
LF-25C-48.5-57	5/29/2001	127.1375	299.1	102.6892	0.32	0.23	70	106.303329	19.30834141			16.264
LF-25C-57-71		45.507	277.6					34.0718386	4.788938521	480.869071	86.69878	14.055
LF-39A-5-20		40.164	229.2					24.8210605	1.939809066			7.8152
LF-39A-20-28		80.65	219.7					47.7951117	4.182769401			8.7515
LF-39A-28-37	5/29/2001	139.99	242.2	91.54034	0.35	0.28	70	98.2494981	17.48114939			12.903
LF-39A-37-46	5/29/2001	141.01	244	92.87859	0.3	0.2	70	98.9199213	15.82820076			13.36
LF-39A-46-55	5/29/2001	104.02	244.6	68.69537	0.3	0.2	70	75.5420848	8.990090469			9.3923
LF-39A-55-62	5/29/2001	56.195	250.4	37.98998	0.3	0.2	70	39.3634825	5.143748331			17.051
LF-39A-62-77		40.758	243.8					26.7971044	3.580719354	411.488263	57.14649	13.362
LF-39B-5-20		37.511	213.7					21.6169276	2.076502902			9.6059
LF-39B-20-28		80.53	230.1					49.9825137	5.243354944			10.49
LF-39B-28-37		136.825	247					91.1383618	10.76676154			11.814
LF-39B-37-46	5/30/2001	130.4	243.3	85.65736	0.35	0.27	70	119.354223	18.19891179			13.034
LF-39B-46-55	5/30/2001	103.56	219	61.23503	0.3	0.2	70	66.2960592	5.204830743			6.1644
LF-39B-55-62	5/30/2001	47.715	224.2	28.88515	0.19	0.12	70	30.242489	2.057565804			6.1033
LF-39B-62-77		34.66	230.8					21.5744333	1.613182644	400.205008	45.16111	7.4773
LF-39C-5-20		38.749	210.6					22.0117092	1.343593403			6.104
LF-39C-20-28		78.93	223.5					47.5831961	3.45257233			7.2559
LF-39C-28-37		129.595	262.1					91.612199	12.92102691			14.104
LF-39C-37-46	5/30/2001	133.575	229	82.58419	0.33	0.25	70	176.742872	20.88145184			9.8734
LF-39C-46-55	5/30/2001	100.955	213.3	58.15008	0.25	0.19	70	63.622726	6.044044096			7.6705
LF-39C-55-62	5/30/2001	51.61	229.3	31.94847	0.21	0.08	70	34.7680439	3.184095785			7.6923
LF-39C-62-77		36.822	202.8					20.140256	0.837884302	456.481002	48.66467	4.1602

APPENDIX E – Method B Output Data on LFCC

The highlighted locations indicated that the vertical is located in the rip rap section and a highlighted sand load indicates that an error occurred, thus the suspended sediment load equation was used to calculated total load. The total sand loads for those sections were determined based on the % sand. SS indicates Suspended Sediment and mb indicates mobile bed.

Table E.1 – BORAMEP Method B Output 300 cfs

***		Q	C	SS	d65	d35	T	Total Load	Total Sand Load >0.625mm	mb SS TL	Total Load mb	mb sand	mb SS total	side slopes	%sand
Location	Date	(cfs)	(PPM)	(tons/day)	(mm)	(mm)	(ºF)	tons/day							
LF-11A-20-32	6/8/2001	38.10	354.46					36.42	11.63	36.42					31.94
LF-11A-32-36.5		51.52	443.13					61.57	27.42	61.57					44.54
LF-11A-36.5-39.5	6/8/2001	35.76	421.45	40.69	0.18	0.14	72	45.58	18.91	40.64					37.10
LF-11A-39.5-42.5	6/8/2001	35.27	451.69	43.01	0.16	0.12	72	57.62	34.00	42.96					47.21
LF-11A-42.5-45.5	6/8/2001	32.20	411.72	35.80	0.18	0.14	72	43.03	20.61	35.76					41.71
LF-11A-45.5-48	6/8/2001	26.37	391.41	27.87	0.21	0.15	72	32.31	13.18	27.83	240.11	114.13	208.76	93.08	36.02
LF-11A-48-63	6/8/2001	53.54	392.48					56.67	22.01	56.67					38.85
LF-11B-20-32		33.17	274.76					24.58	8.76	24.58					35.64
LF-11B-32-36.5	6/8/2001	46.11	296.67	36.93	0.19	0.15	72	42.29	18.14	36.89					36.54
LF-11B-36.5-39.5		32.47	322.00					28.19	12.46	28.19					44.19
LF-11B-39.5-42.5		32.55	290.85					25.53	8.81	25.53					34.50
LF-11B-42.5-45.5	6/8/2001	34.60	256.00	23.91	0.18	0.15	72	28.46	9.19	23.89					26.95
LF-11B-45.5-48		26.81	298.62					21.59	7.23	21.59	146.06	55.82	136.09	69.47	33.49
LF-11B-48-63	6/8/2001	56.41	295.08					44.89	18.58	44.89					41.40
LF-11C-20-32		35.13	245.21					23.23	6.30	23.23					27.10
LF-11C-32-36.5	6/8/2001	49.11	237.62	31.51	0.19	0.15	72	41.44	9.72	31.47					21.50
LF-11C-36.5-39.5	6/8/2001	35.60	203.42	19.55	0.19	0.15	72	24.94	9.09	19.53					31.72
LF-11C-39.5-42.5	6/8/2001	35.26	291.67	27.77	0.18	0.14	72	33.32	16.37	27.73					45.35
LF-11C-42.5-45.5	6/8/2001	35.53	299.40	28.72	0.21	0.16	72	33.08	16.36	28.69					47.97
LF-11C-45.5-48	6/8/2001	28.85	267.89	20.86	0.22	0.16	72	24.48	9.86	20.84	157.25	61.39	128.27	65.03	38.95
LF-11C-48-63	6/8/2001	60.69	255.38					41.80	13.09	41.80					31.33
LF-25A-8-25		34.18	60.36					5.56	0.89	5.56					15.92
LF-25A-25-30.5		8.06	1805.09					39.23	3.22	39.23					8.20
LF-25A-30.5-36	6/11/2001	41.11	1690.46	187.61	0.32	0.21	73	191.80	2.72	187.40					12.01

Table E.1 – BORAMEP Method B Output 300 cfs

***		Q	C	SS	d65	d35	T	Total Load	Total Sand Load >0.625mm	mb SS TL	Total Load mb	mb sand	mb SS total	side slopes	%sand
Location	Date	(cfs)	(PPM)	(tons/day)	(mm)	(mm)	(ºF)	tons/day							
LF-25A-36-42		56.59	1734.22					264.67	20.86	264.67					7.88
LF-25A-42-48	6/11/2001	60.05	1643.04	266.37	0.35	0.28	73	377.34	3.98	266.07					7.88
LF-25A-48-54	6/11/2001	54.32	1670.00	244.93	0.3	0.19	73	255.37	3.40	244.65	1128.41	34.17	1002.01	155.85	27.25
LF-25A-54-68		33.03	1687.05					150.29	22.73	150.29					15.12
LF-25B-8-25		26.16	1548.03					109.21	16.51	109.21					15.12
LF-25B-25-30.5		9.11	1584.38					38.94	3.49	38.94					8.96
LF-25B-30.5-36	6/11/2001	32.83	1677.56	148.70	0.26	0.15	73	157.88	1.98	148.53					27.91
LF-25B-36-42	6/11/2001	57.92	1674.51	261.87	0.17	0.11	73	366.77	4.70	261.57					16.23
LF-25B-42-48	6/11/2001	62.15	1599.48	268.40	0.33	0.26	73	279.56	4.14	268.09					12.11
LF-25B-48-54		55.43	1591.88					237.95	40.88	237.95	1081.09	55.20	955.07	230.65	17.18
LF-25B-54-68		28.85	1560.69					121.44	62.74	121.44					51.67
LF-25C-8-25		34.74	1589.55					148.94	10.52	148.94					7.07
LF-25C-25-30.5		10.90	1623.64					47.72	4.97	47.72					10.41
LF-25C-30.5-36	6/11/2001	34.06	1538.77	141.49	0.26	0.14	73	145.15	1.70	141.33					12.18
LF-25C-36-42		56.98	1578.00					242.47	23.83	242.47					9.83
LF-25C-42-48	6/11/2001	58.14	1517.14	238.16	0.36	0.28	73	289.45	4.16	237.88					9.13
LF-25C-48-54		54.41	1528.97					224.36	19.45	224.36	949.15	54.11	893.76	282.71	8.67
LF-25C-54-68		31.48	1575.77					133.77	26.92	133.77					20.12
LF-39A-11-29		51.61	132.04					18.38	7.52	18.38					40.90
LF-39A-29-34.5		43.11	149.62					17.40	0.18	17.40					1.03
LF-39A-34.5-39.5		40.55	169.09					18.49	0.25	18.49					1.37
LF-39A-39.5-44.5	6/9/2001	42.91	169.17	19.60	0.08	0.033	72	38.65	4.05	19.58					1.70
LF-39A-44.5-49.5	6/9/2001	36.20	184.74	18.06	0.24	0.17	72	24.59	2.35	18.04					1.08

Table E.1 – BORAMEP Method B Output 300 cfs

***		Q	C	SS	d65	d35	T	Total Load	Total Sand Load >0.625mm	mb SS TL	Total Load mb	mb sand	mb SS total	side slopes	%sand
Location	Date	(cfs)	(PPM)	(tons/day)	(mm)	(mm)	(ºF)	tons/day							
LF-39A-49.5-56		38.01	178.13					18.26	0.18	18.26	117.38	7.02	91.76	37.09	1.00
LF-39A-56-73		37.59	184.58					18.71	0.46	18.71					2.45
LF-39B-11-29		54.87	151.80					22.46	0.22	22.46					0.97
LF-39B-29-34.5	6/9/2001	41.60	171.07	19.21	0.31	0.22	73	20.41	2.00	19.19					1.14
LF-39B-34.5-39.5	6/9/2001	39.50	162.06	17.28	0.32	0.23	73	25.78	8.21	17.26					1.31
LF-39B-39.5-44.5	6/9/2001	39.06	151.90	16.02	0.1	0.064	73	21.80	4.64	16.00					1.22
LF-39B-44.5-49.5		34.96	157.64					14.86	0.20	14.86					1.32
LF-39B-49.5-56		36.39	158.63					15.57	0.19	15.57	98.42	15.23	82.88	40.05	1.20
LF-39B-56-73		31.03	210.20					17.59	0.37	17.59					2.09
LF-39C-11-29		55.65	163.73					24.57	0.19	24.57					0.77
LF-39C-29-34.5	6/9/2001	44.20	163.03	19.46	0.34	0.27	72	33.40	3.91	19.43					1.19
LF-39C-34.5-39.5	6/9/2001	42.49	168.23	19.30	0.32	0.22	72	20.93	2.68	19.27					1.13
LF-39C-39.5-44.5	6/9/2001	40.08	170.16	18.41	0.14	0.088	72	23.91	3.45	18.39					1.42
LF-39C-44.5-49.5	6/9/2001	34.79	166.21	15.61	0.29	0.2	72	24.53	2.13	15.60					1.34
LF-39C-49.5-56	6/9/2001	37.02	163.80	16.37	0.28	0.19	72	20.15	1.74	16.35	122.93	13.90	89.05	40.22	1.13
LF-39C-56-73		32.44	178.91					15.65	0.89	15.65					5.69

Table E.2 – BORAMEP Method B Output 600 cfs

***		Q	C	SS	d65	d35	T	Total Load	Total Sand Load >0.625 mm	mb SS TL	TL mb	mb sand total	mb SS TL	side slopes	%sand
Location	Date	(cfs)	(PPM)	tons /day	(mm)	(mm)	ºF	tons /day							
LF-11A-15-34	5/27/01	142.75	579.23					223.00	81.74	223.00					36.65
LF-11A-34-38		93.71	643.31					162.57	68.41	162.57					42.08
LF-11A-38-42	5/27/01	91.07	715.04	175.81	0.30	0.19	70	200.96	104.33	175.61					46.16
LF-11A-42-46	5/27/01	91.16	690.07	169.84	0.19	0.15	70	201.28	85.05	169.64					41.95
LF-11A-46-50	5/27/01	86.61	535.77	125.29	0.14	0.03	70	157.64	68.93	125.14	722.45	326.71	632.97	394.32	38.19
LF-11A-50-54		56.64	555.87					84.91	30.17	84.91					35.53
LF-11A-54-66		59.50	538.57					86.42	22.35	86.42					25.86
LF-11B-15-34	5/27/01	138.66	565.56					211.49	66.62	211.49					31.50
LF-11B-34-38		88.05	699.11					166.01	73.40	166.01					44.21
LF-11B-38-42		89.06	731.40					175.67	79.35	175.67					45.17
LF-11B-42-46		88.93	593.27					142.28	79.40	142.28					55.81
LF-11B-46-50	5/27/01	83.11	586.54	131.62	0.18	0.14	70	133.08	47.89	131.47	617.04	280.04	615.43	362.30	35.76
LF-11B-50-54	5/27/01	49.96	537.50					72.42	23.69	72.42					32.71
LF-11B-54-66	5/27/01	57.47	505.77					78.39	21.52	78.39					27.45
LF-11C-15-34		130.85	593.47					209.42	85.70	209.42					40.92
LF-11C-34-38	5/27/01	91.67	566.55	140.23	0.19	0.15	70	166.00	66.53	140.06					38.32
LF-11C-38-42	5/27/01	90.58	644.26	157.56	0.28	0.11	70	184.10	97.88	157.37					46.06
LF-11C-42-46	5/27/01	87.43	752.93	177.73	0.20	0.16	70	199.20	109.25	177.52					51.27
LF-11C-46-50		75.13	579.15					117.34	49.81	117.34	666.65	323.48	592.30	336.81	42.44
LF-11C-50-54		46.51	499.61					62.67	21.05	62.67					33.59
LF-11C-54-66	5/27/01	57.11	420.20					64.72	15.74	64.72					24.33
LF-25A-5-21		72.11	266.27					51.78	4.45	51.78					8.60
LF-25A-21-27.5		31.87	314.33					27.02	3.41	27.02					12.62
LF-25A-27.5-34.5		67.34	320.79					58.25	8.61	58.25					14.78
LF-25A-34.5-41.5	5/28/01	120.76	337.95	110.19	0.38	0.31	70	116.16	21.96	110.06					16.74
LF-25A-41.5-48.5	5/28/01	126.33	325.95	111.18	0.34	0.27	70	118.14	22.71	111.05					16.91
LF-25A-48.5-57	5/28/01	127.59	310.20	106.86	0.35	0.28	70	112.52	19.07	106.74	432.09	75.75	413.12	82.10	15.37
LF-25A-57-71		40.97	274.42					30.32	3.46	30.32					11.42
LF-25B-5-21		65.56	274.89					48.60	4.82	48.60					9.91
LF-25B-21-27.5		33.07	305.95					27.29	3.41	27.29					12.48
LF-25B-27.5-34.5		61.11	316.52					52.16	8.74	52.16					16.76
LF-25B-34.5-41.5	5/28/01	116.95	332.57	105.02	0.35	0.29	70	114.25	24.62	104.90					19.33
LF-25B-41.5-48.5	5/28/01	118.92	307.01	98.58	0.36	0.30	70	103.22	19.96	98.46					17.09
LF-25B-48.5-57	5/28/01	129.47	311.57	108.91	0.33	0.26	70	118.75	16.44	108.79	415.68	73.17	391.60	81.95	11.97
LF-25B-57-71		40.91	302.30					33.35	3.98	33.35					11.94

Table E.2 – BORAMEP Method B Output 600 cfs

***		Q	C	SS	d65	d35	T	Total Load	Total Sand Load >0.625 mm	mb SS TL	TL mb	mb sand total	mb SS TL	side slopes	%sand
Location	Date	(cfs)	(PPM)	tons /day	(mm)	(mm)	ºF	tons /day							
LF-25C-5-21		68.48	271.94					50.22	5.90	50.22					11.75
LF-25C-21-27.5		30.24	294.61					24.03	3.40	24.03					14.17
LF-25C-27.5-34.5		65.86	303.87					53.97	10.37	53.97					19.21
LF-25C-34.5-41.5	5/29/01	113.92	307.60	94.61	0.38	0.29	70	103.48	20.06	94.50					17.21
LF-25C-41.5-48.5	5/29/01	122.00	306.23	100.87	0.37	0.29	70	108.79	22.87	100.76					18.09
LF-25C-48.5-57	5/29/01	127.14	299.15	102.69	0.32	0.23	70	106.30	19.31	102.57	396.58	76.01	375.83	84.29	16.26
LF-25C-57-71		45.51	277.62					34.07	4.79	34.07					14.06
LF-39A-5-20		40.16	229.15					24.82	1.94	24.82					7.82
LF-39A-20-28		80.65	219.74					47.80	4.18	47.80					8.75
LF-39A-28-37	5/29/01	139.99	242.19	91.54	0.35	0.28	70	98.25	17.48	91.43					12.90
LF-39A-37-46	5/29/01	141.01	243.95	92.88	0.30	0.20	70	98.92	15.83	92.77					13.36
LF-39A-46-55	5/29/01	104.02	244.59	68.70	0.30	0.20	70	75.54	8.99	68.62					9.39
LF-39A-55-62	5/29/01	56.20	250.38	37.99	0.30	0.20	70	39.36	5.14	37.95	359.87	51.63	338.56	51.62	17.05
LF-39A-62-77		40.76	243.79					26.80	3.58	26.80					13.36
LF-39B-5-20		37.51	213.68					21.62	2.08	21.62					9.61
LF-39B-20-28		80.53	230.14					49.98	5.24	49.98					10.49
LF-39B-28-37		136.83	246.99					91.14	10.77	91.14					11.81
LF-39B-37-46	5/30/01	130.40	243.29	85.66	0.35	0.27	70	119.35	18.20	85.56					13.03
LF-39B-46-55	5/30/01	103.56	219.00	61.24	0.30	0.20	70	66.30	5.20	61.16					6.16
LF-39B-55-62	5/30/01	47.72	224.21	28.89	0.19	0.12	70	30.24	2.06	28.85	357.01	41.47	316.70	43.19	6.10
LF-39B-62-77		34.66	230.81					21.57	1.61	21.57					7.48
LF-39C-5-20		38.75	210.63					22.01	1.34	22.01					6.10
LF-39C-20-28		78.93	223.54					47.58	3.45	47.58					7.26
LF-39C-28-37		129.60	262.12					91.61	12.92	91.61					14.10
LF-39C-37-46	5/30/01	133.58	228.99	82.58	0.33	0.25	70	176.74	20.88	82.49					9.87
LF-39C-46-55	5/30/01	100.96	213.33	58.15	0.25	0.19	70	63.62	6.04	58.08					7.67
LF-39C-55-62	5/30/01	51.61	229.27	31.95	0.21	0.08	70	34.77	3.18	31.91	414.33	46.48	311.68	42.15	7.69
LF-39C-62-77		36.82	202.81					20.14	0.84	20.14					4.16

APPENDIX F – Method C Output Data on LFCC

The highlighted locations indicated that the vertical are located in the rip rap section. Total load determined based on the suspended sediment load equation. BORAMEP not used.

Table F.1 – Method C Results 300 cfs

***		Q	C	SS	d65	d35	Temp	Total Load	Cross Section total
Location	Date	(cfs)	(PPM)	(tons/day)	(mm)	(mm)	F	(tons/day)	(tons/day)
LF-11A-20-32	6/8/2001	38.098	354.461539					36.419518	
LF-11A-32-36.5		51.5175	443.125					61.566424	
LF-11A-36.5-39.5	6/8/2001	35.7575	421.4546	40.68943	0.18	0.14	72	40.64254	
LF-11A-39.5-42.5	6/8/2001	35.265	451.6923	43.00811	0.16	0.12	72	42.958536	
LF-11A-42.5-45.5	6/8/2001	32.2025	411.7188	35.79761	0.18	0.14	72	35.75635	
LF-11A-45.5-48	6/8/2001	26.3675	391.4084	27.86525	0.21	0.15	72	27.833126	
LF-11A-48-63	6/8/2001	53.535	392.48					56.665436	301.84
LF-11B-20-32		33.168	274.761905					24.577556	
LF-11B-32-36.5	6/8/2001	46.11	296.6667	36.93411	0.19	0.15	72	36.891543	
LF-11B-36.5-39.5		32.465	322					28.192538	
LF-11B-39.5-42.5		32.55	290.847458					25.531666	
LF-11B-42.5-45.5	6/8/2001	34.5975	256	23.91379	0.18	0.15	72	23.886228	
LF-11B-45.5-48		26.8075	298.62069					21.589327	
LF-11B-48-63	6/8/2001	56.41	295.076923					44.890479	205.56
LF-11C-20-32		35.127	245.208333					23.229464	
LF-11C-32-36.5	6/8/2001	49.1125	237.6238	31.5098	0.19	0.15	72	31.473488	
LF-11C-36.5-39.5	6/8/2001	35.6	203.4247	19.55318	0.19	0.15	72	19.530645	
LF-11C-39.5-42.5	6/8/2001	35.2575	291.6667	27.76528	0.18	0.14	72	27.733281	
LF-11C-42.5-45.5	6/8/2001	35.53	299.3985	28.7216	0.21	0.16	72	28.688492	
LF-11C-45.5-48	6/8/2001	28.845	267.8911	20.86376	0.22	0.16	72	20.839712	
LF-11C-48-63	6/8/2001	60.688	255.384615					41.798476	193.3
LF-25A-8-25		34.183	60.3603604					5.5644839	
LF-25A-25-30.5		8.0585	1805.09434					39.229883	
LF-25A-30.5-36	6/11/2001	41.1055	1690.455	187.6149	0.32	0.21	73	187.39864	
LF-25A-36-42		56.59	1734.21687					264.67078	
LF-25A-42-48	6/11/2001	60.045	1643.04	266.3721	0.35	0.28	73	266.06508	
LF-25A-48-54	6/11/2001	54.32	1670	244.9289	0.3	0.19	73	244.64657	
LF-25A-54-68		33.032	1687.04762					150.28828	1157.86
LF-25B-8-25		26.159	1548.02817					109.21012	
LF-25B-25-30.5		9.1135	1584.375					38.940908	
LF-25B-30.5-36	6/11/2001	32.8295	1677.557	148.6981	0.26	0.15	73	148.52667	

Table F.1 – Method C Results 300 cfs

*** Location	Date	Q (cfs)	C (PPM)	SS (tons/day)	d65 (mm)	d35 (mm)	Temp F	Total Load (tons/day)	Cross Section total (tons/day)
LF-25B-36-42	6/11/2001	57.92	1674.513	261.8671	0.17	0.11	73	261.5652	
LF-25B-42-48	6/11/2001	62.15	1599.484	268.4014	0.33	0.26	73	268.09204	
LF-25B-48-54		55.425	1591.88406					237.94689	
LF-25B-54-68		28.853	1560.69444					121.4428	1185.72
LF-25C-8-25		34.744	1589.54955					148.94186	
LF-25C-25-30.5		10.898	1623.63636					47.719784	
LF-25C-30.5-36	6/11/2001	34.056	1538.767	141.4915	0.26	0.14	73	141.32838	
LF-25C-36-42		56.975	1578					242.46789	
LF-25C-42-48	6/11/2001	58.14	1517.143	238.1581	0.36	0.28	73	237.88357	
LF-25C-48-54		54.41	1528.97059					224.35758	
LF-25C-54-68		31.478	1575.76923					133.77121	1176.47
LF-39A-11-29		51.6076	132.040816					18.377429	
LF-39A-29-34.5		43.11	149.622642					17.395553	
LF-39A-34.5-39.5		40.5525	169.090909					18.49272	
LF-39A-39.5-44.5	6/9/2001	42.91	169.1667	19.59914	0.08	0.033	72	19.576556	
LF-39A-44.5-49.5	6/9/2001	36.2025	184.7368	18.05743	0.24	0.17	72	18.036608	
LF-39A-49.5-56		38.005	178.125					18.256962	
LF-39A-56-73		37.589	184.583333					18.711825	128.85
LF-39B-11-29		54.871	151.803279					22.463991	
LF-39B-29-34.5	6/9/2001	41.595	171.0667	19.2119	0.31	0.22	73	19.189758	
LF-39B-34.5-39.5	6/9/2001	39.4975	162.0635	17.28298	0.32	0.23	73	17.263057	
LF-39B-39.5-44.5	6/9/2001	39.055	151.8965	16.01726	0.1	0.064	73	15.998796	
LF-39B-44.5-49.5		34.9575	157.636364					14.861398	
LF-39B-49.5-56		36.385	158.627451					15.565519	
LF-39B-56-73		31.026	210.2					17.5882	122.93
LF-39C-11-29		55.6503	163.72549					24.572351	
LF-39C-29-34.5	6/9/2001	44.2025	163.0303	19.45714	0.34	0.27	72	19.43471	
LF-39C-34.5-39.5	6/9/2001	42.485	168.2258	19.2971	0.32	0.22	72	19.274855	
LF-39C-39.5-44.5	6/9/2001	40.08	170.1639	18.41446	0.14	0.088	72	18.393232	
LF-39C-44.5-49.5	6/9/2001	34.7925	166.2069	15.61343	0.29	0.2	72	15.595438	
LF-39C-49.5-56	6/9/2001	37.0205	163.8	16.37269	0.28	0.19	72	16.353815	
LF-39C-56-73		32.4405	178.909091					15.652469	129.28

Table F.2 – Method C Results 600 cfs

*** Location	Date	Q (cfs)	C (PPM)	SS (tons/day)	d65 (mm)	d35 (mm)	Temp F	Total Load (tons/day)	Cross Section total (tons/day)
LF-11A-15-34	5/27/2001	142.752	579.2308					222.99583	
LF-11A-34-38		93.705	643.307087					162.57134	
LF-11A-38-42	5/27/2001	91.065	715.04	175.8108	0.3	0.19	70	175.60817	
LF-11A-42-46	5/27/2001	91.155	690.073	169.8397	0.19	0.15	70	169.64397	
LF-11A-46-50	5/27/2001	86.61	535.7692	125.288	0.14	0.028	70	125.14361	
LF-11A-50-54		56.64	555.867769					84.909764	
LF-11A-54-66		59.497	538.571429					86.417415	1027.29
LF-11B-15-34	5/27/2001	138.661	565.5555					211.49127	
LF-11B-34-38		88.05	699.107143					166.01067	
LF-11B-38-42		89.06	731.403509					175.67203	
LF-11B-42-46		88.925	593.272727					142.27911	
LF-11B-46-50	5/27/2001	83.11	586.5421	131.6183	0.175	0.135	70	131.46658	
LF-11B-50-54	5/27/2001	49.96	537.5					72.420879	
LF-11B-54-66	5/27/2001	57.468	505.7692					78.386515	977.73
LF-11C-15-34		130.848	593.469388					209.42489	
LF-11C-34-38	5/27/2001	91.67	566.5455	140.2251	0.19	0.15	70	140.06348	
LF-11C-38-42	5/27/2001	90.575	644.2623	157.5559	0.28	0.11	70	157.37435	
LF-11C-42-46	5/27/2001	87.425	752.9293	177.7271	0.2	0.16	70	177.52223	
LF-11C-46-50		75.13	579.145299					117.34479	
LF-11C-50-54		46.51	499.607843					62.666939	
LF-11C-54-66	5/27/2001	57.111	420.202					64.720338	929.12
LF-25A-5-21		72.107	266.26506					51.779101	
LF-25A-21-27.5		31.8695	314.333333					27.016469	
LF-25A-27.5-34.5		67.335	320.787402					58.253371	
LF-25A-34.5-41.5	5/28/2001	120.76	337.9487	110.1889	0.38	0.31	70	110.06184	
LF-25A-41.5-48.5	5/28/2001	126.325	325.9542	111.1756	0.34	0.27	70	111.0475	
LF-25A-48.5-57	5/28/2001	127.5875	310.1987	106.8592	0.35	0.28	70	106.73602	
LF-25A-57-71		40.966	274.423077					30.318456	495.21
LF-25B-5-21		65.56	274.893617					48.603383	
LF-25B-21-27.5		33.0745	305.950413					27.290232	
LF-25B-27.5-34.5		61.1085	316.521739					52.163661	
LF-25B-34.5-41.5	5/28/2001	116.9525	332.5714	105.0167	0.35	0.29	70	104.89561	
LF-25B-41.5-48.5	5/28/2001	118.92	307.013	98.57696	0.36	0.3	70	98.463339	
LF-25B-48.5-57	5/28/2001	129.4675	311.5714	108.9136	0.33	0.26	70	108.78806	
LF-25B-57-71		40.906	302.300885					33.3495	473.55

Table F.2 – Method C Results 600 cfs

*** Location	Date	Q (cfs)	C (PPM)	SS (tons/day)	d65 (mm)	d35 (mm)	Temp F	Total Load (tons/day)	Cross Section total (tons/day)
LF-25C-5-21		68.475	271.942446					50.219448	
LF-25C-21-27.5		30.24325	294.608696					24.029067	
LF-25C-27.5-34.5		65.85725	303.870968					53.970407	
LF-25C-34.5-41.5	5/29/2001	113.9175	307.6	94.61076	0.38	0.29	70	94.501711	
LF-25C-41.5-48.5	5/29/2001	122.0025	306.2295	100.8741	0.37	0.29	70	100.75779	
LF-25C-48.5-57	5/29/2001	127.1375	299.1489	102.6892	0.32	0.23	70	102.57085	
LF-25C-57-71		45.507	277.622378					34.071839	460.12
LF-39A-5-20		40.164	229.150327					24.821061	
LF-39A-20-28		80.65	219.74359					47.795112	
LF-39A-28-37	5/29/2001	139.99	242.1875	91.54034	0.35	0.28	70	91.434824	
LF-39A-37-46	5/29/2001	141.01	243.9506	92.87859	0.3	0.2	70	92.771525	
LF-39A-46-55	5/29/2001	104.02	244.5946	68.69537	0.3	0.2	70	68.616191	
LF-39A-55-62	5/29/2001	56.195	250.3846	37.98998	0.3	0.2	70	37.946191	
LF-39A-62-77		40.758	243.787879					26.797104	390.18
LF-39B-5-20		37.511	213.684211					21.616928	
LF-39B-20-28		80.53	230.142857					49.982514	
LF-39B-28-37		136.825	246.986301					91.138362	
LF-39B-37-46	5/30/2001	130.4	243.2895	85.65736	0.35	0.27	70	85.558636	
LF-39B-46-55	5/30/2001	103.56	219	61.23503	0.3	0.2	70	61.164447	
LF-39B-55-62	5/30/2001	47.715	224.2105	28.88515	0.19	0.12	70	28.851857	
LF-39B-62-77		34.66	230.806452					21.574433	359.89
LF-39C-5-20		38.749	210.634921					22.011709	
LF-39C-20-28		78.93	223.536585					47.583196	
LF-39C-28-37		129.595	262.121212					91.612199	
LF-39C-37-46	5/30/2001	133.575	228.9855	82.58419	0.33	0.25	70	82.489004	
LF-39C-46-55	5/30/2001	100.955	213.3333	58.15008	0.25	0.19	70	58.083045	
LF-39C-55-62	5/30/2001	51.61	229.2727	31.94847	0.21	0.08	70	31.911638	
LF-39C-62-77		36.822	202.8125					20.140256	353.83

APPENDIX G – Method D Output Data on LFCC

Table G.1 – BORAMEP Method D Output 300 cfs

Location	Date	Discharge (cfs)	Conc (ppm)	Suspended Sample (tons/day)	d65 (mm)	d35 (mm)	Temp (F)	Total Load (tons/day)	Total Sand Load (>0.0625) (tons/day)	%>sand
LF-11A	6/8/2001	280.16	394.6028	298.4901	0.21	0.17	72	351.090381	146.9372433	38.0145162
LF-11B	6/8/2001	272.743	288.637					212.309048	79.67877835	37.5296198
LF-11C	6/8/2001	262.108	253.39008					179.11534	56.83157397	31.7290378
LF-25A	6/11/2001	280.7	1570.35	1190.153	0.29	0.14	73	1238.45095	18.04885138	11.9115363
LF-25B	6/11/2001	272.4	1235.898	908.9779	0.29	0.15	73	906.548452	83.63524376	14.5925213
LF-25C	6/11/2001	287.3	1588.369	1232.113	0.3	0.19	73	1254.26305	15.03489891	25.688785
LF-39A	6/9/2001	286.6713	168.9171	130.744	0.2	0.07	72	188.959772	29.5331819	2.14626263
LF-39B	6/9/2001	277.4	163.0703	122.1364	0.2	0.097	73	153.527925	28.81315002	12.7573554
LF-39C	6/9/2001	289.9766	171.5449	134.3088	0.19	0.07	72	179.353368	37.71999131	1.36282647

Table G.2 – BORAMEP Method D Output 600 cfs

Location	Date	Discharge (cfs)	Conc (ppm)	Suspended Sample (tons/day)	d65 (mm)	d35 (mm)	Temp (F)	Total Load (tons/day)	Total Sand Load (>0.0625) (tons/day)	%>sand
LF-11A	5/27/2001	621	588.7935	987.2301	0.082	0.001	70	1424.19396	578.4373034	35.7339788
LF-11B	5/27/2001	595.2	576.58996					925.535101	323.4931017	34.9520079
LF-11C	5/27/2001	579.3	558.5942	873.7027	0.1	0.0005	70	1227.52209	512.1096752	37.5722404
LF-25A	5/28/2001	587	302.4286	479.3191	0.39	0.28	70	508.888561	73.42319855	13.3455981
LF-25B	5/28/2001	566	298.1038	455.5623	0.39	0.29	70	473.719985	65.00746053	12.8659141
LF-25C	5/29/2001	573	289.6881	448.1765	0.37	0.26	70	528.462422	85.55739266	15.1009544
LF-39A	5/29/2001	603	238.6293	388.5123	0.31	0.2	70	430.608782	53.8123042	11.4990487
LF-39B	5/30/2001	571	228.8677	352.8454	0.3	0.19	70	398.0067	41.47435172	9.2118714
LF-39C	5/30/2001	570	221.3929	340.7238	0.302	0.2	70	376.512425	33.70996487	7.59999432

Total load determined by taking averages of all original inputted data.

APPENDIX H – Suspended Sediment versus Bed Load Overlap Graphs

Figure H.1 – Overlap Graph at LF-11A 20 - 32

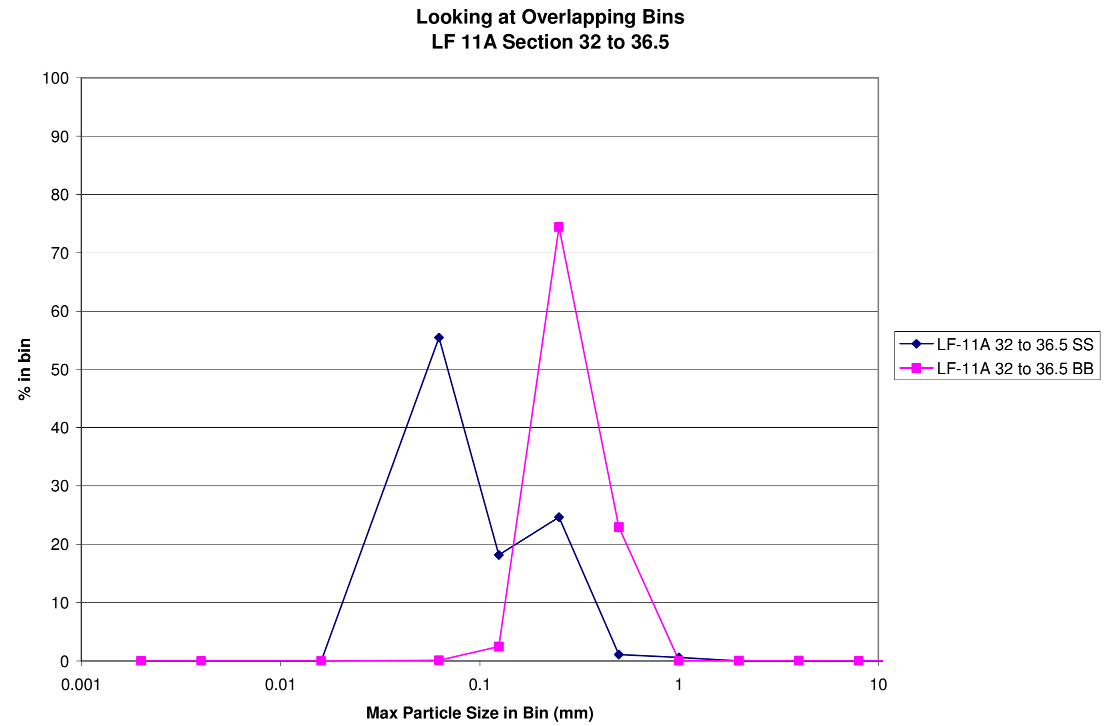


Figure H.2 – Overlap Graph at LF-11A 32 – 36.5

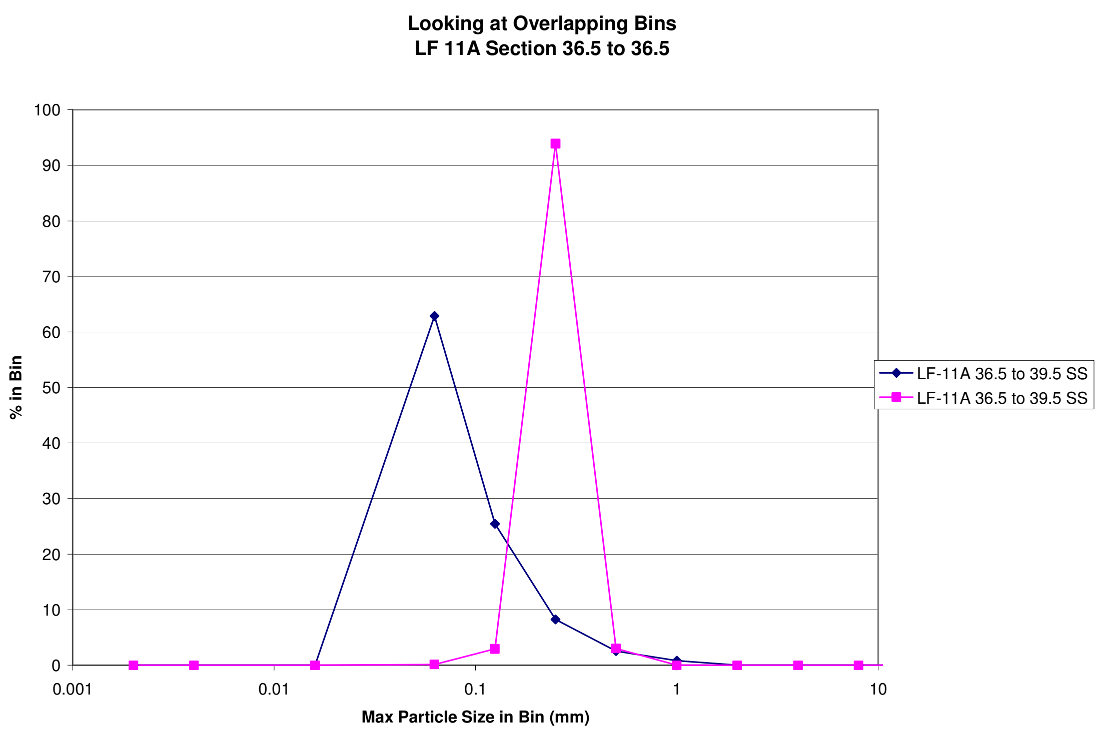


Figure H.3 – Overlap Graph at LF-11A 36.5 – 39.5

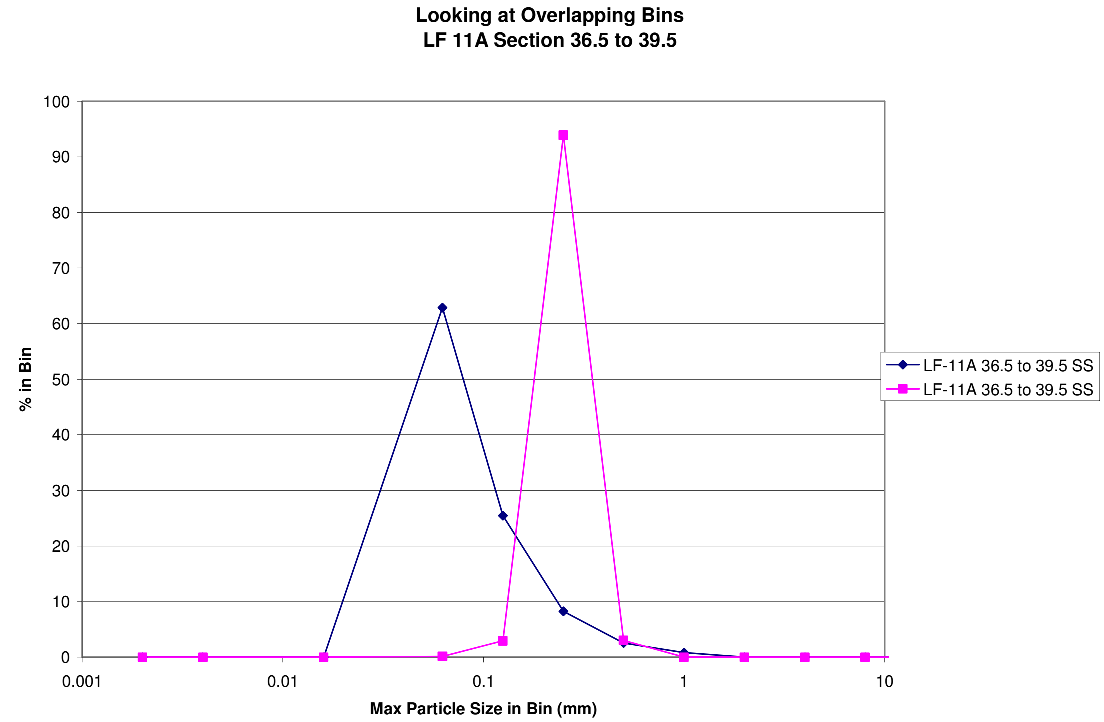


Figure H.4 – Overlap Graph at LF-11A 39.5 -42.5

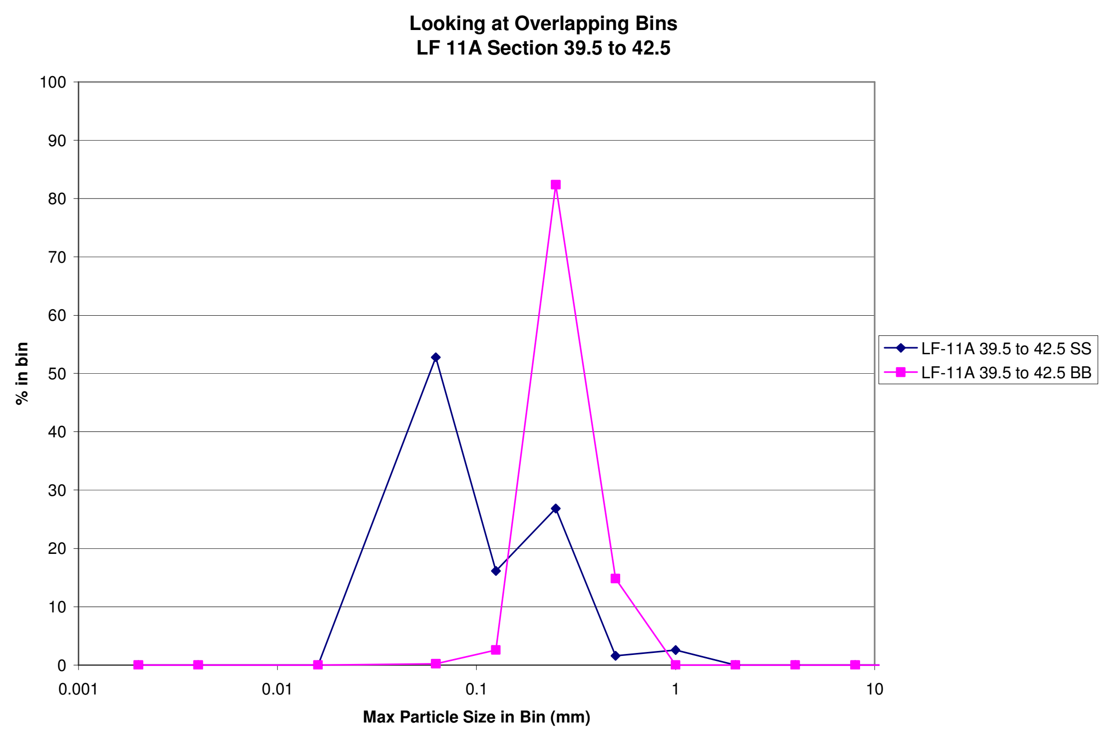


Figure H.5 – Overlap Graph at LF-11A 42.5 – 45.5

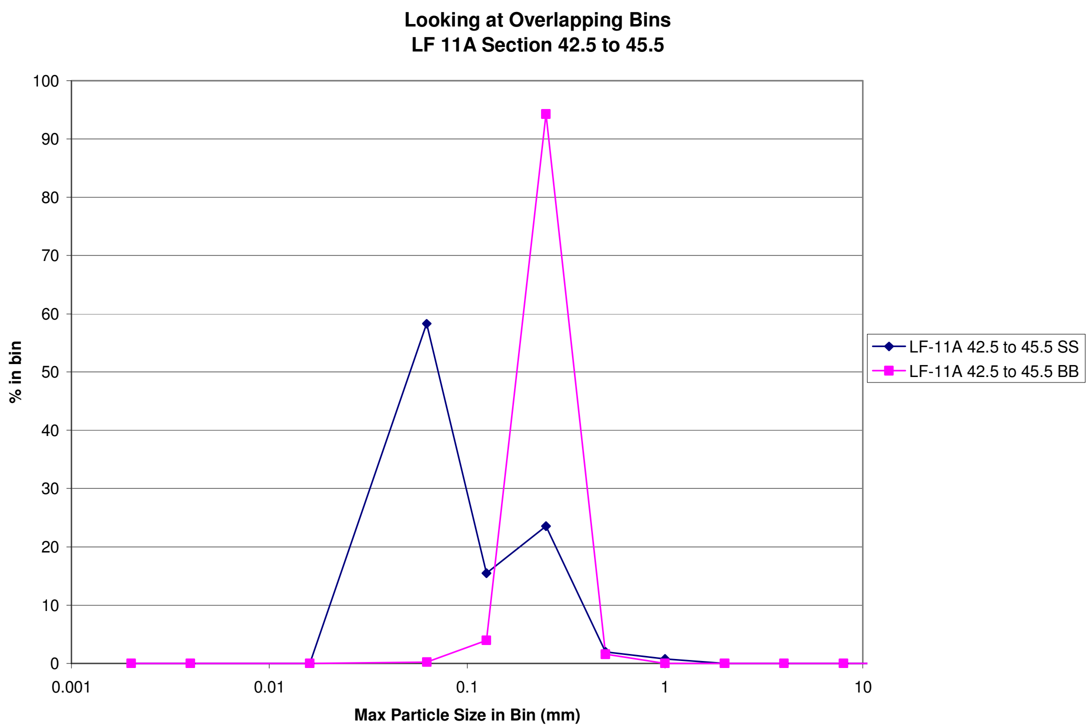


Figure H.6 – Overlap Graph at LF-11A 45.5 – 48

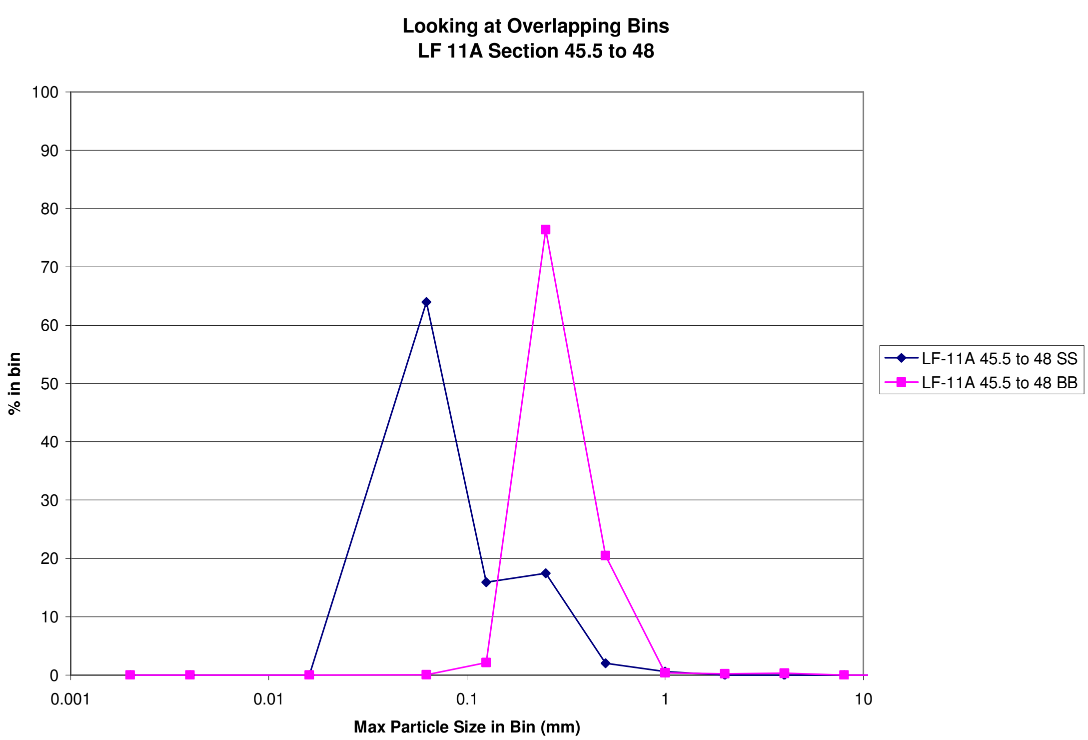


Figure H.7 – Overlap Graph at LF-11A 48 – 63

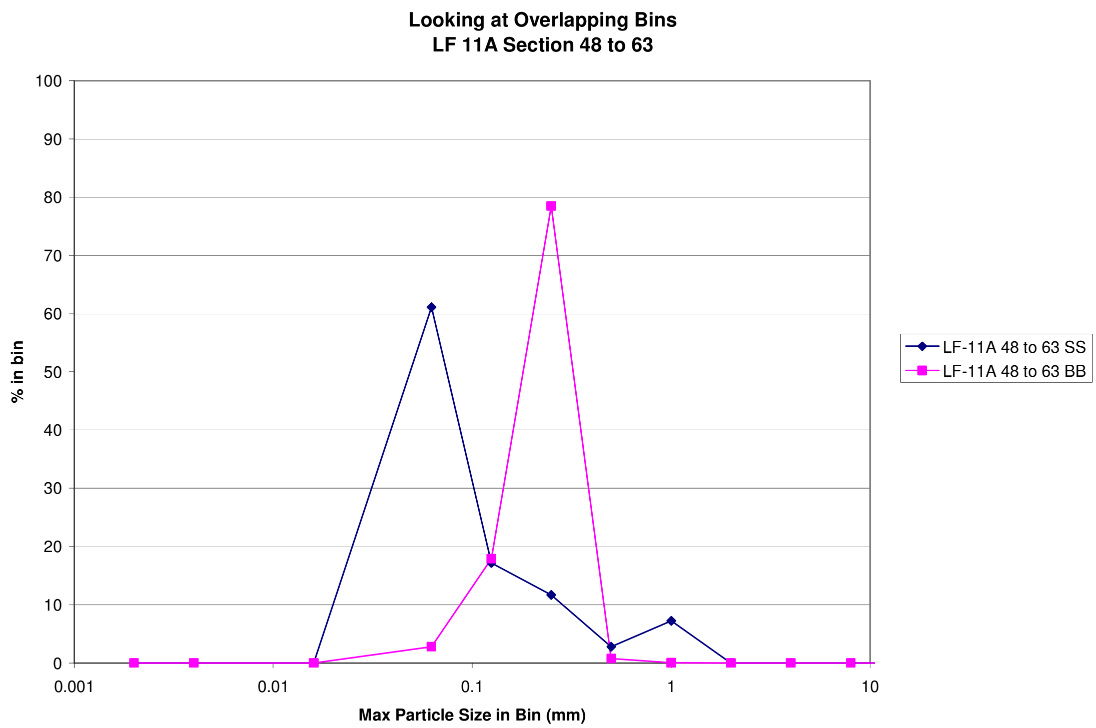


Figure H.8 – Overlap Graph at LF-11B 20 – 32

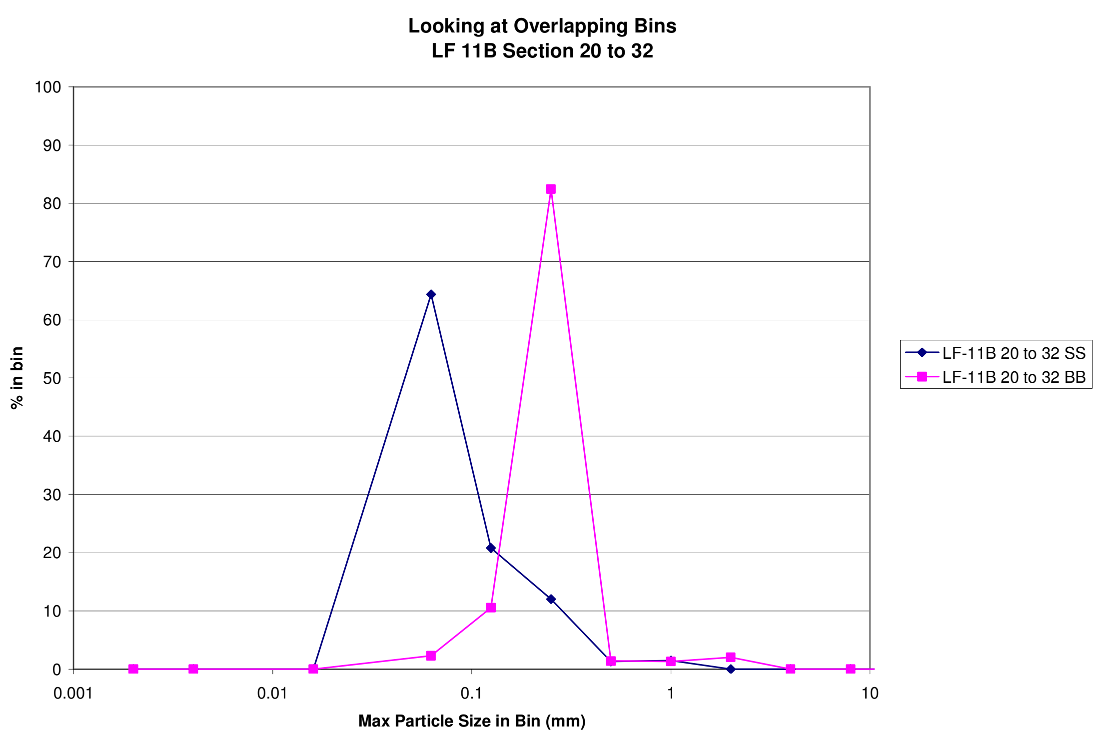


Figure H.9 – Overlap Graph at LF-11B 32 – 35.5

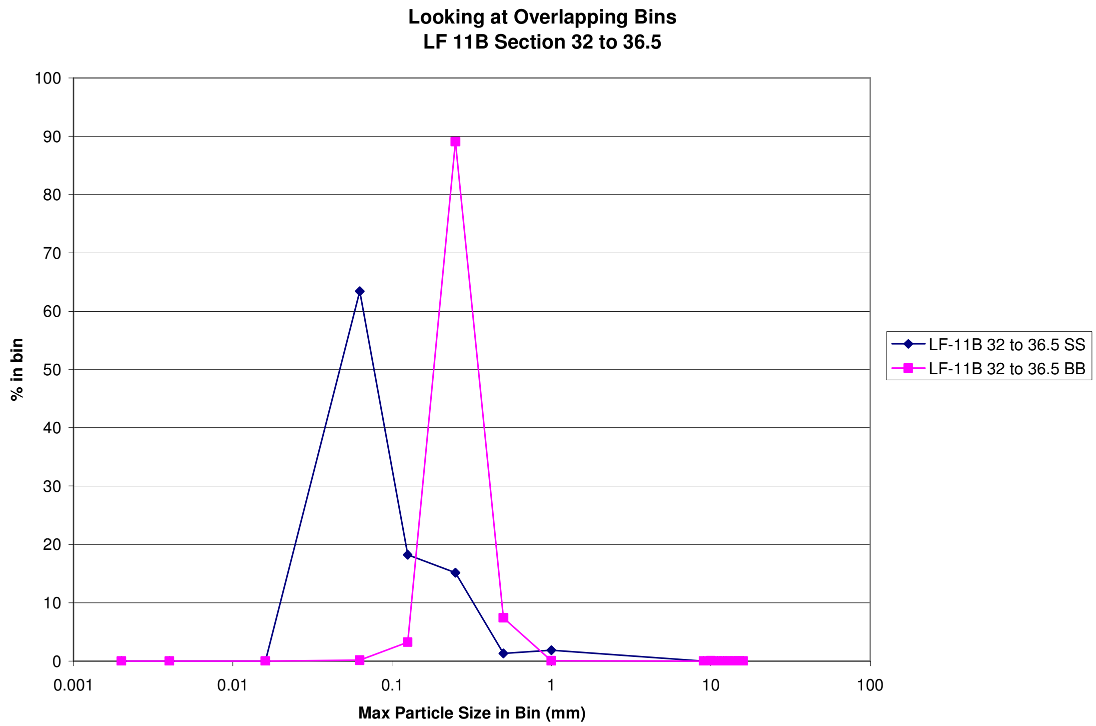


Figure H.10 – Overlap Graph at LF-11B 35.5 – 39.5

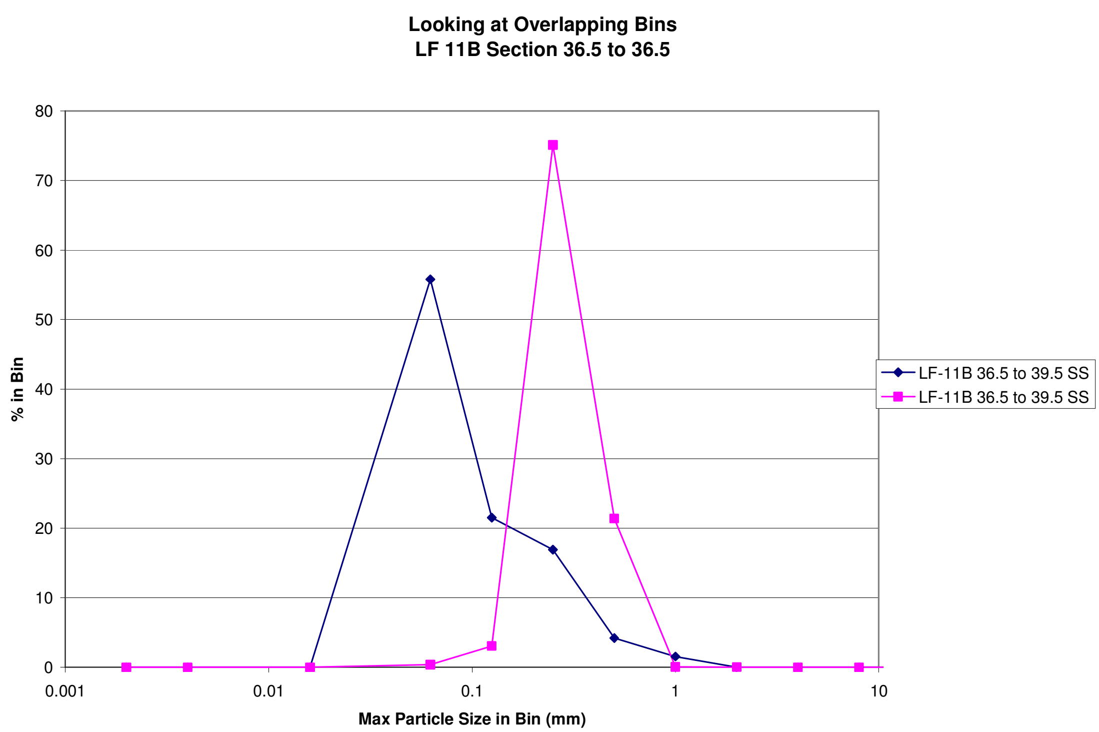


Figure H.11 – Overlap Graph at LF-11B 39.5 – 42.5

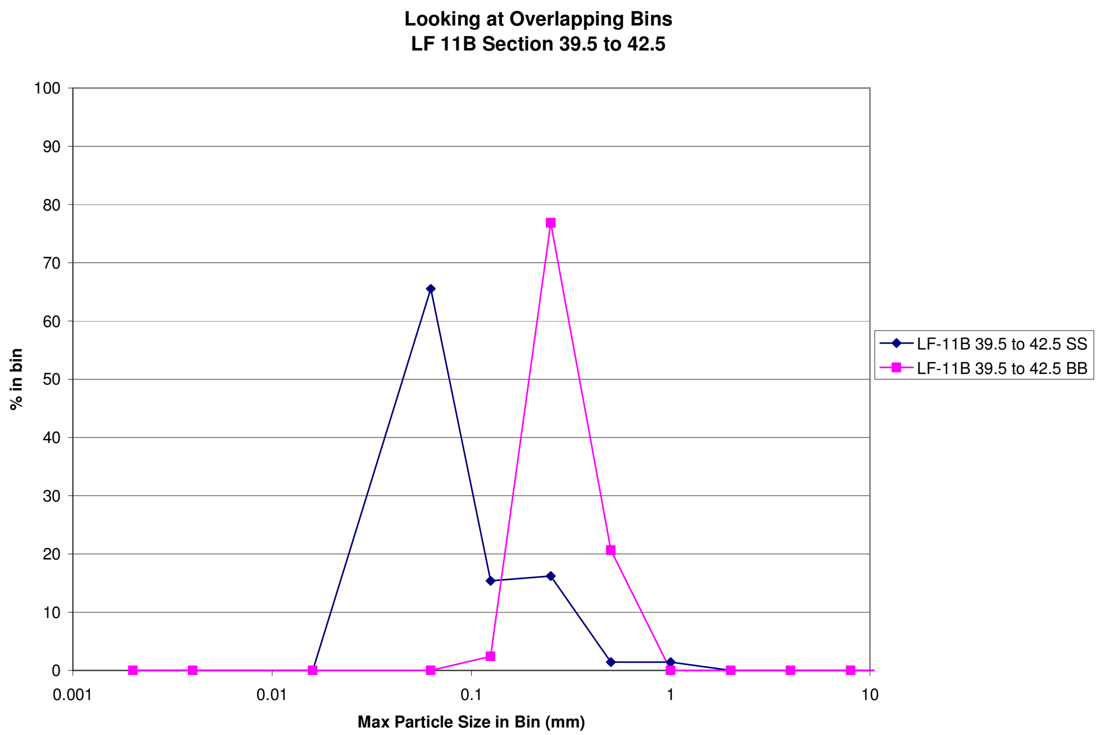


Figure H.12 – Overlap Graph at LF-11B 42.5 – 45.5

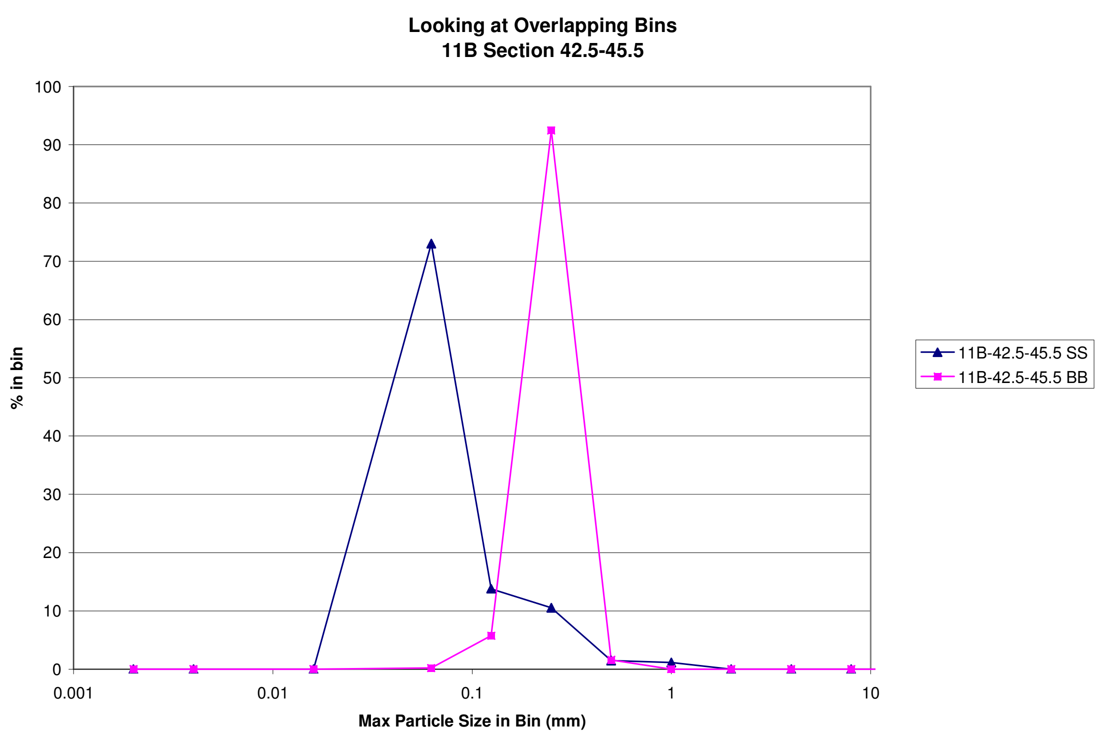


Figure H.13 – Overlap Graph at LF-11B 45.5 – 48

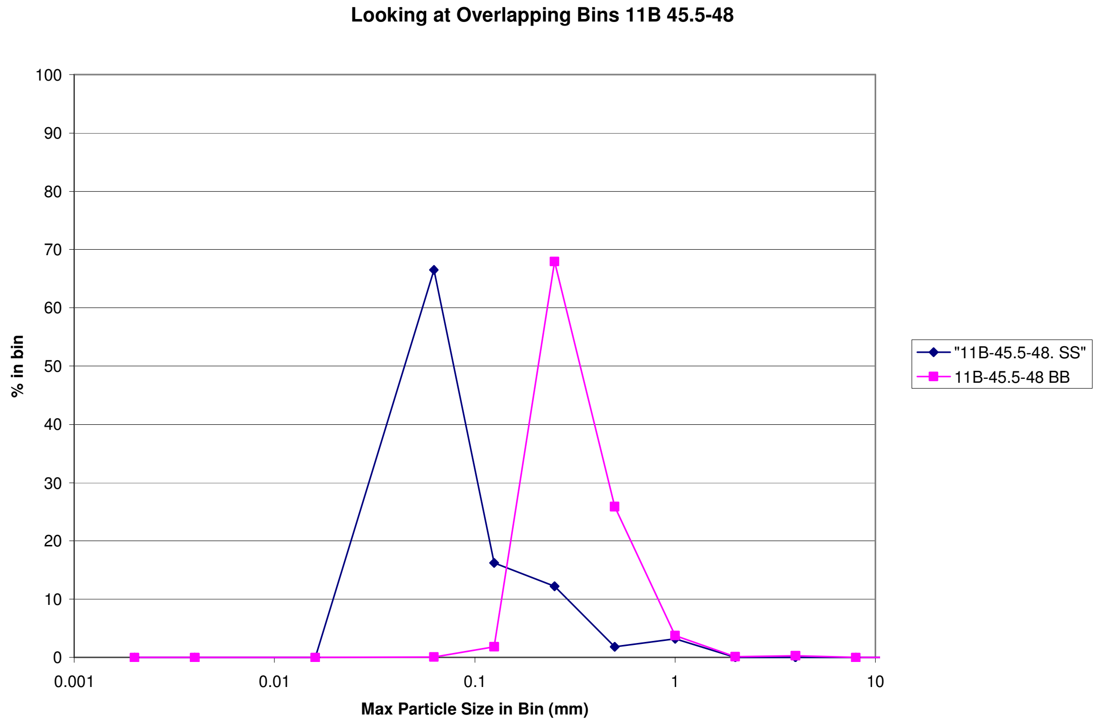


Figure H.14 – Overlap Graph at LF-11B 48 – 63

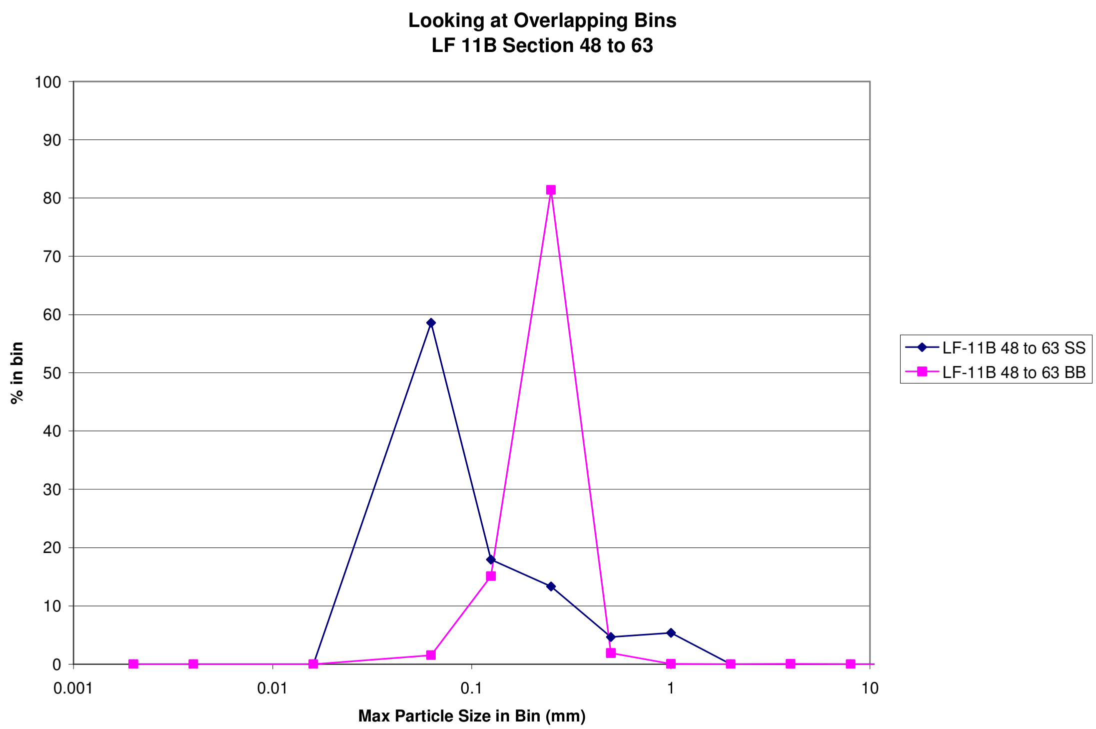


Figure H.15 – Overlap Graph at LF-11C 20 – 32

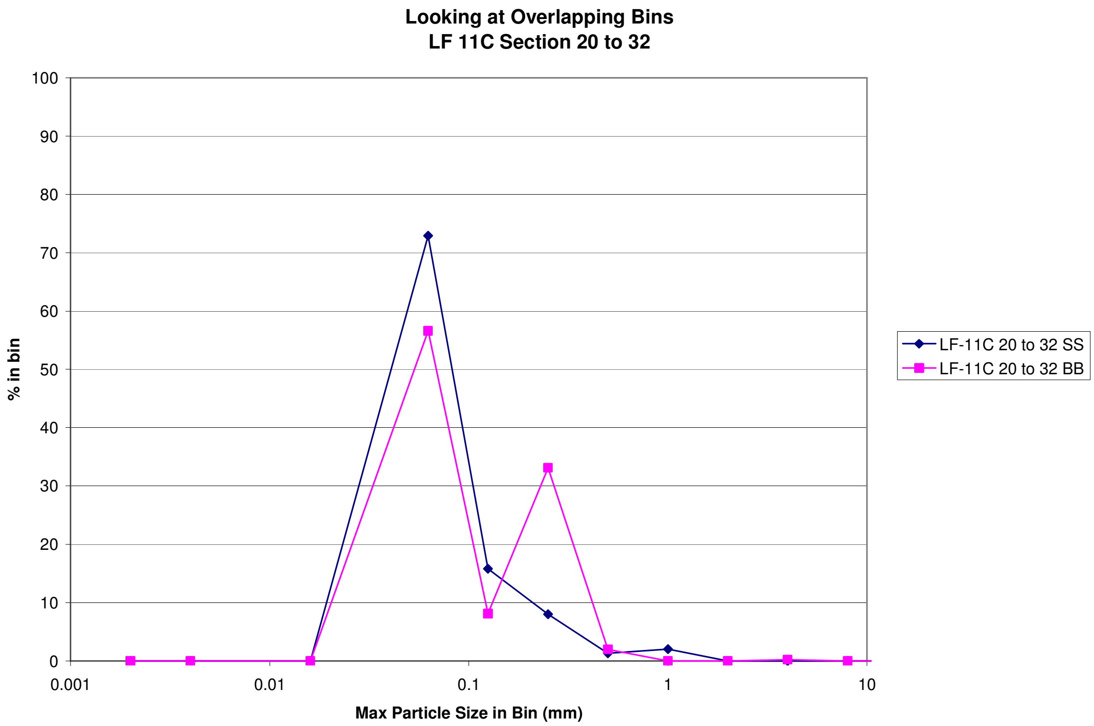


Figure H.16 – Overlap Graph at LF-11C 32 – 35.5

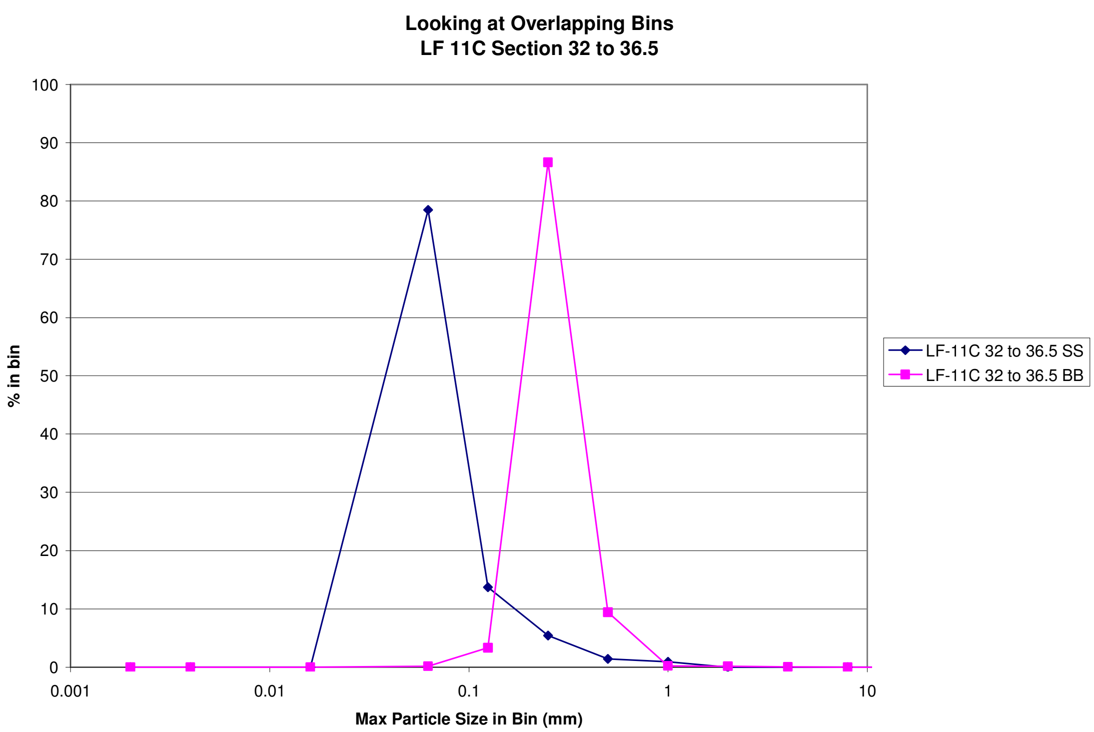


Figure H.17 – Overlap Graph at LF-11C 35.5 – 39.5

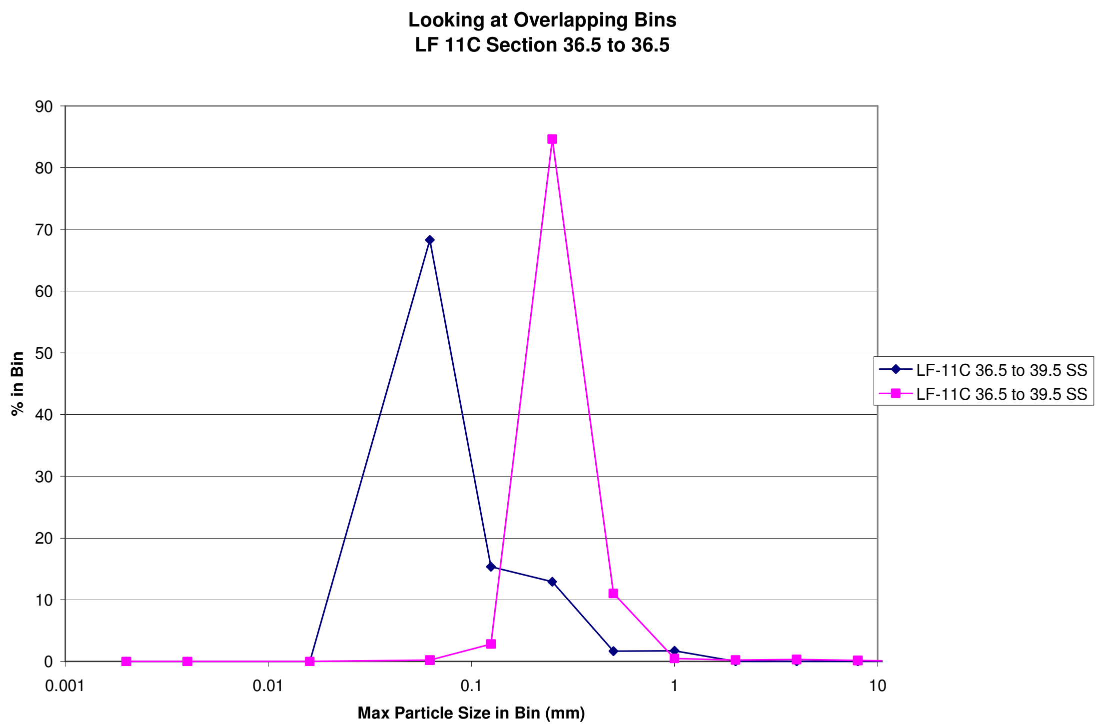


Figure H.18 – Overlap Graph at LF-11C 39.5 – 42.5

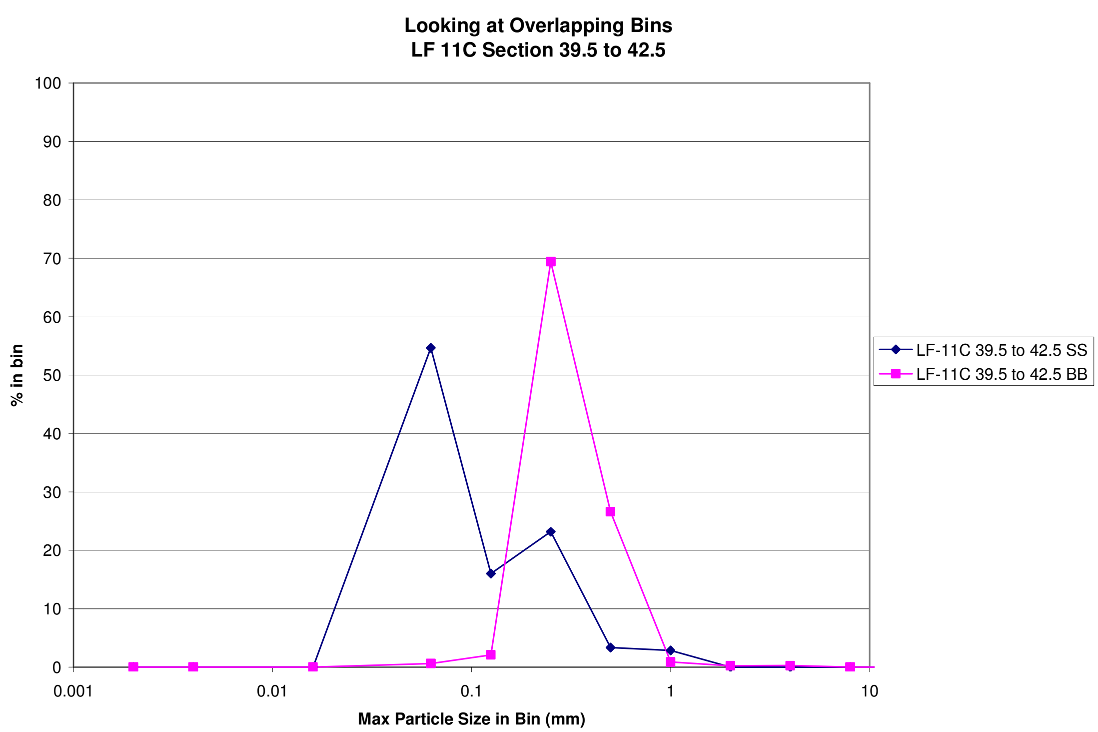


Figure H.19 – Overlap Graph at LF-11C 42.5 – 45.5

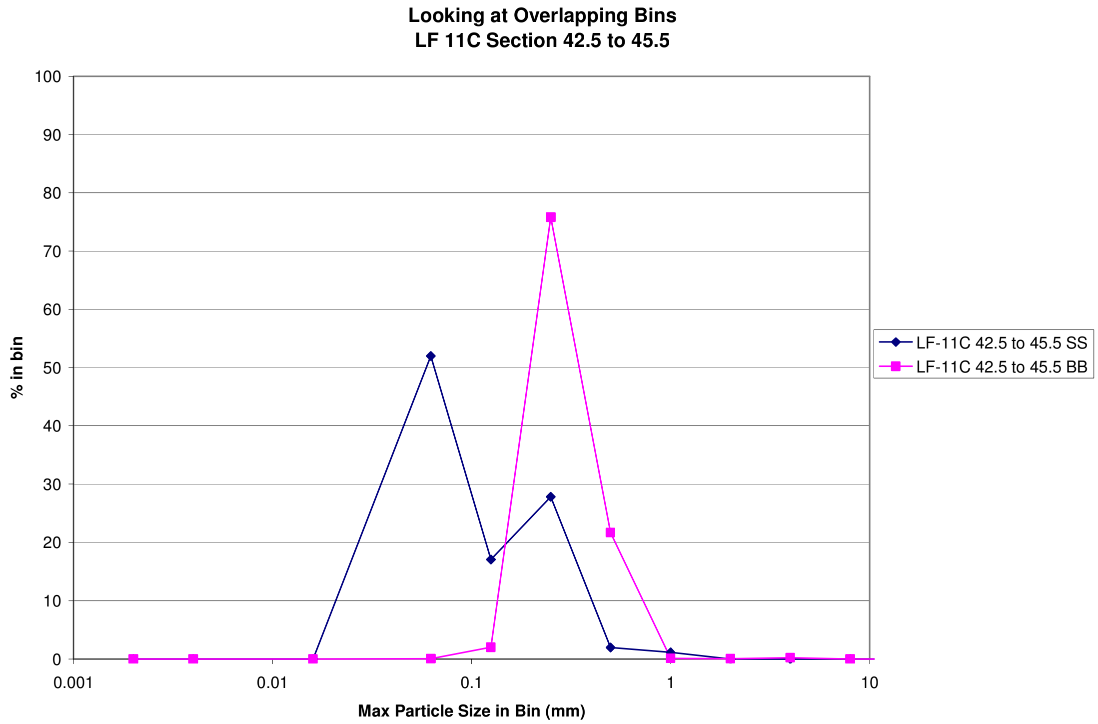


Figure H.20 – Overlap Graph at LF-11C 45.5 – 48

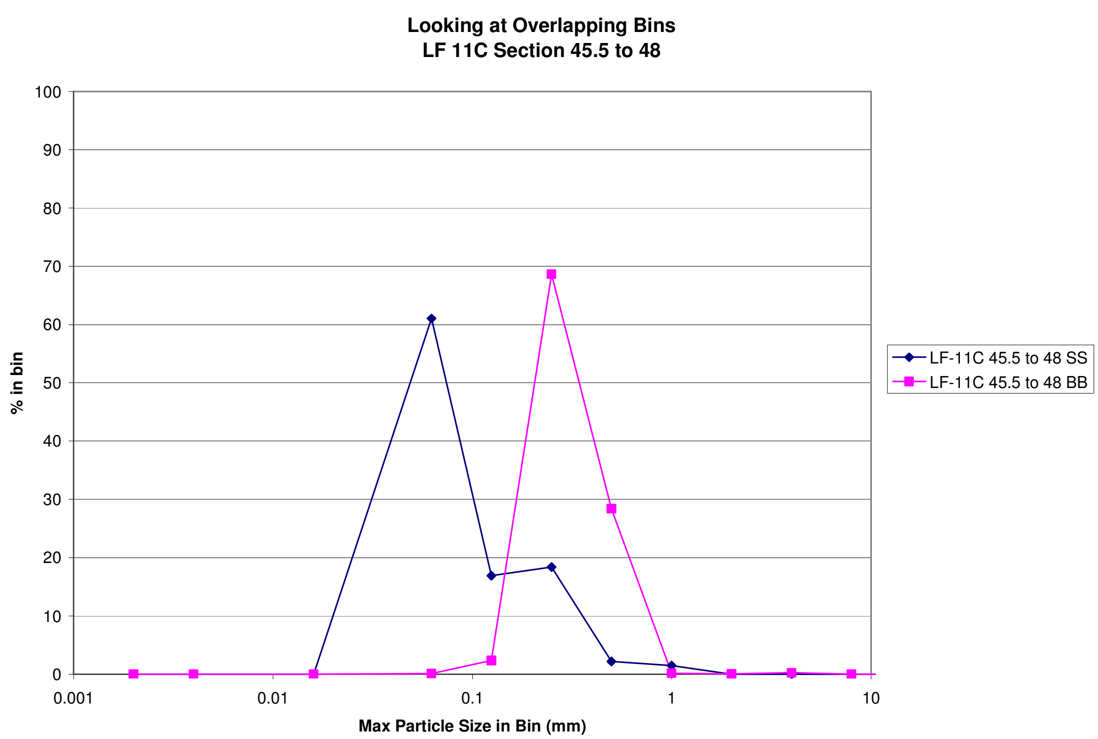
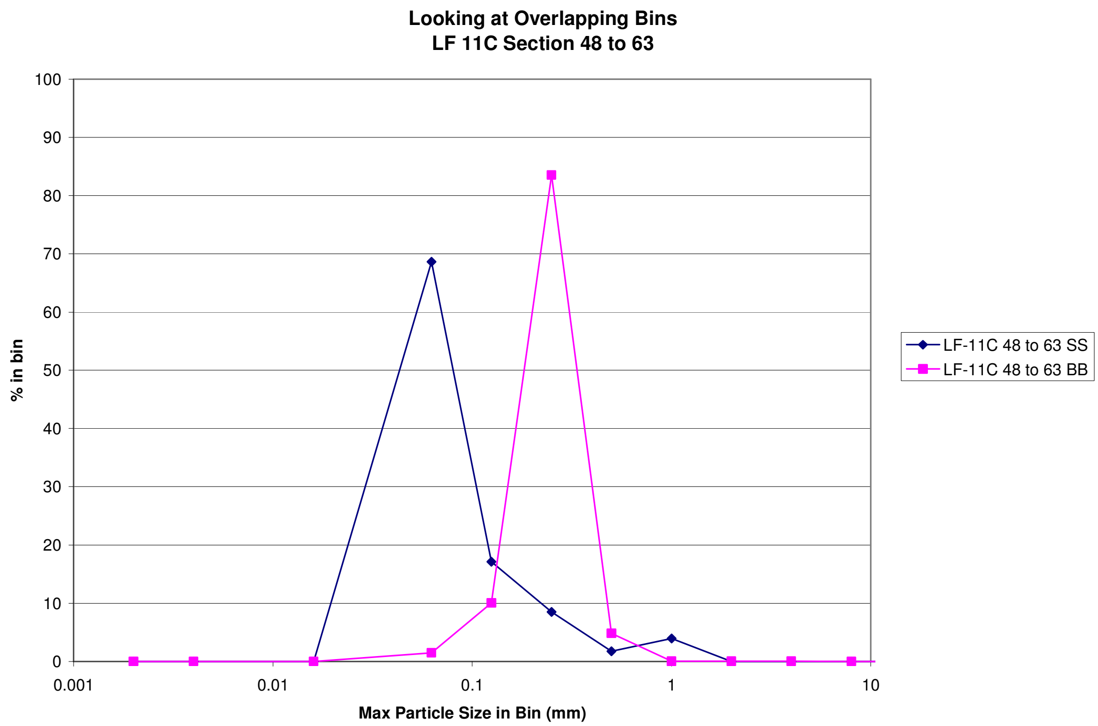


Figure H.21 – Overlap Graph at LF-11C 48 – 63



APPENDIX I – Data on percent overlap at cross section 11 and vertical selection

Table I.1 – Calculated Total Load and Sand Load for Different Percent Overlap

Station Location	Flow Rate (cfs)	Percent overlap									
		5		4		3		2		1.5	
		TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day
LF-11A-20-32	38.1										
LF-11A-32-36.5	51.5							78.3	43.6	78.3	43.6
LF-11A-36.5-39.5	35.8							45.6	18.9	45.6	18.9
LF-11A-39.5-42.5	35.3							61.5	38.1	57.6	34.0
LF-11A-42.5-45.5	32.2					47.2	25.6	47.2	25.6	43.0	20.6
LF-11A-45.5-48	26.4							33.5	15.3	33.5	15.3
LF-11A-48-63	53.5	63.3	26.2	63.3	26.2	63.3	26.2	63.3	26.2	63.3	26.2
Total	**272.7**										

Station Location	Flow Rate (cfs)	Percent overlap									
		5		4		3		2		1.5	
		TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day
LF-11B-20-32	33.2										
LF-11B-32-36.5	46.1					44.8	20.9	44.8	20.9	44.8	20.9
LF-11B-36.5-39.5	32.5			41.4	22.7	33.4	17.2	33.4	17.2	33.4	17.2
LF-11B-39.5-42.5	32.6							33.8	16.7	32.4	15.1
LF-11B-42.5-45.5	34.6	30.1	12.0	30.1	12.0	30.1	12.0	30.1	12.0	28.5	9.2
LF-11B-45.5-48	26.8										
LF-11B-48-63	56.4	47.7	20.3	47.7	20.3	47.7	20.3	47.7	20.3	49.7	19.3
Total	**262.1**										

Table I.1 – Calculated Total Load and Sand Load for Different Percent Overlap											
Station Location	**Flow Rate (cfs)**	**Percent overlap**									
		5		**4**		**3**		**2**		**1.5**	
		TL tons/day	**SL tons/day**	**TL tons/day**	**SL tons/day**	**TL tons/day**	**SL tons/day**	**TL tons/day**	**SL tons/day**	**TL tons/day**	**SL tons/day**
LF-11C-20-32	35.1	33.7	11.4	33.7	11.4	33.7	11.4	33.7	11.4	33.7	11.4
LF-11C-32-36.5	49.1					38.5	13.2	38.5	13.2	36.4	10.4
LF-11C-36.5-39.5	35.6							26.7	13.0	24.7	10.7
LF-11C-39.5-42.5	35.3					40.1	23.7	35.8	20.2	35.8	20.2
LF-11C-42.5-45.5	35.5									34.4	19.2
LF-11C-45.5-48	28.8							24.9	11.9	24.9	11.9
LF-11C-48-63	60.7	49.0	18.9	49.0	18.9	49.0	18.9	49.0	18.9	48.3	16.8
Total	**280.2**										

Station Location	**Flow Rate (cfs)**	**Percent overlap**									
		1.4		**1.3**		**1.25**		**1**		**0**	
		TL tons/day	**SL tons/day**	**TL tons/day**	**SL tons/day**	**TL tons/day**	**SL tons/day**	**TL tons/day**	**SL tons/day**	**TL tons/day**	**SL tons/day**
LF-11A-20-32	38.1									41.7	14.6
LF-11A-32-36.5	51.5	78.3	43.6	78.3	43.6	78.3	43.6	76.5	41.7		
LF-11A-36.5-39.5	35.8	45.6	18.9	45.6	18.9	45.6	18.9	45.6	18.9	45.6	18.9
LF-11A-39.5-42.5	35.3	57.6	34.0	57.6	34.0	57.6	34.0	57.6	34.0	57.6	34.0
LF-11A-42.5-45.5	32.2	43.0	20.6	43.0	20.6	43.0	20.6	43.0	20.6	43.0	20.6
LF-11A-45.5-48	26.4	33.5	15.3	33.5	15.3	33.5	15.3	33.5	15.3	32.3	13.2
LF-11A-48-63	53.5	63.3	26.2	63.3	26.2	63.3	26.2	63.3	26.2	69.9	23.7
Total	**272.7**										

Table I.1 – Calculated Total Load and Sand Load for Different Percent Overlap

Station Location	Flow Rate (cfs)	Percent overlap									
		1.4		1.3		1.25		1		0	
		TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day
LF-11B-20-32	33.2										
LF-11B-32-36.5	46.1	44.8	20.9	42.3	18.1	42.3	18.1	42.3	18.1	42.3	18.1
LF-11B-36.5-39.5	32.5	33.4	17.2	33.4	17.2	33.4	17.2	33.4	17.2		
LF-11B-39.5-42.5	32.6	32.4	15.1	32.4	15.1	32.4	15.1	32.4	15.1		
LF-11B-42.5-45.5	34.6	28.5	9.2	28.5	9.2	28.5	9.2	28.5	9.2	28.5	9.2
LF-11B-45.5-48	26.8										
LF-11B-48-63	56.4	49.7	19.3	49.7	19.3	49.7	19.3	49.7	19.3	49.7	19.3
Total	**262.1**										

Station Location	Flow Rate (cfs)	Percent overlap									
		1.4		1.3		1.25		1		0	
		TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day	TL tons/day	SL tons/day
LF-11C-20-32	35.1	33.7	11.4	33.7	11.4						
LF-11C-32-36.5	49.1	36.4	10.4	36.4	10.4	36.4	10.4	36.4	10.4	41.4	9.7
LF-11C-36.5-39.5	35.6	24.7	10.7	24.7	10.7	24.7	10.7	24.7	10.7	24.9	9.1
LF-11C-39.5-42.5	35.3	35.8	20.2	35.8	20.2	35.8	20.2	35.8	20.2	33.3	16.4
LF-11C-42.5-45.5	35.5	34.4	19.2	34.4	19.2	34.4	19.2	34.4	19.2	33.1	16.4
LF-11C-45.5-48	28.8	24.9	11.9	24.9	11.9	24.9	11.9	24.9	11.9	24.5	9.9
LF-11C-48-63	60.7	48.3	16.8	48.3	16.8	48.3	16.8	48.3	16.8	48.3	16.8
Total	**280.2**										

Table I.2 – Overall Summary

Station Location	Flow Rate (cfs)	Overall Min, Max and Averages at each Vertical. And Totals for Cross Section								
		Total Load tons/day			Sand Load >0.625 tons/day			Washload		
		Average	Min	Max	Average	Min	Max	Average	Min	Max
LF-11A-20-32	38.1	41.7	41.7	41.7	7.3	14.6	14.6	34.4	27.1	27.1
LF-11A-32-36.5	51.5	78.0	76.5	78.3	37.1	41.7	43.6	40.9	34.8	34.7
LF-11A-36.5-39.5	35.8	45.6	45.6	45.6	16.5	18.9	18.9	29.0	26.7	26.7
LF-11A-39.5-42.5	35.3	58.2	57.6	61.5	30.3	34.0	38.1	27.9	23.6	23.4
LF-11A-42.5-45.5	32.2	44.1	43.0	47.2	19.4	20.6	25.6	24.6	22.4	21.5
LF-11A-45.5-48	26.4	33.3	32.3	33.5	13.1	13.2	15.3	20.2	19.1	18.3
LF-11A-48-63	53.5	63.9	63.3	69.9	23.6	23.7	26.2	40.3	39.5	43.7
Total	**272.7**									

Station Location	Flow Rate (cfs)	Overall Min, Max and Averages at each Vertical. And Totals for Cross Section								
		Total Load tons/day			Sand Load >0.625 tons/day			Washload		
		Average	Min	Max	Average	Min	Max	Average	Min	Max
LF-11B-20-32	33.2									
LF-11B-32-36.5	46.1	43.5	42.3	44.8	17.4	18.1	20.9	26.2	24.2	23.8
LF-11B-36.5-39.5	32.5	34.4	33.4	41.4	15.9	17.2	22.7	18.5	16.2	18.6
LF-11B-39.5-42.5	32.6	32.7	32.4	33.8	13.2	15.1	16.7	19.5	17.3	17.1
LF-11B-42.5-45.5	34.6	29.1	28.5	30.1	9.4	9.2	12.0	19.8	19.3	18.1
LF-11B-45.5-48	26.8									
LF-11B-48-63	56.4	48.9	47.7	49.7	17.9	19.3	20.3	31.0	28.4	29.4
Total	**262.1**	***Missing Data Due to Errors***								

Table I.2 – Overall Summary										
Station Location	Flow Rate (cfs)	Overall Min, Max and Averages at each Vertical. And Totals for Cross Section								
		Total Load tons/day			Sand Load >0.625 tons/day			Washload		
		Average	Min	Max	Average	Min	Max	Average	Min	Max
LF-11C-20-32	35.1	33.7	33.7	33.7	9.9	11.4	11.4	23.7	22.3	22.3
LF-11C-32-36.5	49.1	37.5	36.4	41.4	9.8	9.7	13.2	27.7	26.7	28.3
LF-11C-36.5-39.5	35.6	25.0	24.7	26.7	9.4	9.1	13.0	15.6	15.6	13.7
LF-11C-39.5-42.5	35.3	36.0	33.3	40.1	17.9	16.4	23.7	18.1	16.9	16.4
LF-11C-42.5-45.5	35.5	34.2	33.1	34.4	16.1	16.4	19.2	18.1	16.7	15.2
LF-11C-45.5-48	28.8	24.8	24.5	24.9	10.1	9.9	11.9	14.7	14.6	13.0
LF-11C-48-63	60.7	48.6	48.3	49.0	16.0	16.8	18.9	32.5	31.4	30.1
Total	**280.2**									

APPENDIX J – Data on Variability Analysis

Table J.1 – Detailed Data for Modification of Concentration

Modified Concentration on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	53.54	1.48	0.00		0.2	0.15	72	3.1	15			UNKNOWN ERROR OCCURED DURING MEP
11A-Case-2	53.54	1.48	10.00	1.45	0.2	0.15	72	3.1	15	3.75	2.59	
11A-Case-3	53.54	1.48	20.00	2.89	0.2	0.15	72	3.1	15	5.77	3.57	
11A-Case-4	53.54	1.48	40.00	5.78	0.2	0.15	72	3.1	15	9.41	5.22	
11A-Case-5	53.54	1.48	80.00	11.56	0.2	0.15	72	3.1	15	16.14	8.08	
11A-Case-6	53.54	1.48	100.00	14.45	0.2	0.15	72	3.1	15	19.37	9.40	
11A-Case-7	53.54	1.48	200.00	28.91	0.2	0.15	72	3.1	15	34.84	15.50	
11A-Case-8	53.54	1.48	300.00	43.36	0.2	0.15	72	3.1	15	49.75	21.17	
11A-Case-9	53.54	1.48	400.00	57.82	0.2	0.15	72	3.1	15	64.34	26.59	
11A-Case-10	53.54	1.48	500.00	72.27	0.2	0.15	72	3.1	15	78.74	31.87	
11A-Case-11	53.54	1.48	600.00	86.73	0.2	0.15	72	3.1	15	92.99	37.04	
11A-Case-12	53.54	1.48	700.00	101.18	0.2	0.15	72	3.1	15	107.12	42.12	
11A-Case-13	53.54	1.48	800.00	115.64	0.2	0.15	72	3.1	15	121.16	47.13	
11A-Case-14	53.54	1.48	900.00	130.09	0.2	0.15	72	3.1	15	135.13	52.09	
11A-Case-15	53.54	1.48	1000.00	144.54	0.2	0.15	72	3.1	15	149.04	57.00	
11A-Case-16	53.54	1.48	2000.00	289.09	0.2	0.15	72	3.1	15	285.95	104.44	
11A-Case-17	53.54	1.48	3000.00		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-18	53.54	1.48	4000.00		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-19	53.54	1.48	5000.00		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-20	53.54	1.48	10000.00		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified Concentration on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	34.60	2.16	0.00		0.18	0.15	72	5.4	3			UNKNOWN ERROR OCCURED DURING MEP
11B-Case-2	34.60	2.16	10.00	0.93	0.18	0.15	72	5.4	3	1.98	1.03	
11B-Case-3	34.60	2.16	20.00	1.87	0.18	0.15	72	5.4	3	3.28	1.52	
11B-Case-4	34.60	2.16	40.00	3.74	0.18	0.15	72	5.4	3	5.67	2.33	
11B-Case-5	34.60	2.16	80.00	7.47	0.18	0.15	72	5.4	3	10.14	3.76	
11B-Case-6	34.60	2.16	100.00	9.34	0.18	0.15	72	5.4	3	12.30	4.42	
11B-Case-7	34.60	2.16	200.00	18.68	0.18	0.15	72	5.4	3	22.75	7.53	
11B-Case-8	34.60	2.16	300.00	28.02	0.18	0.15	72	5.4	3	32.89	10.46	
11B-Case-9	34.60	2.16	400.00	37.37	0.18	0.15	72	5.4	3	42.87	13.28	
11B-Case-10	34.60	2.16	500.00	46.71	0.18	0.15	72	5.4	3	52.73	16.04	
11B-Case-11	34.60	2.16	600.00	56.05	0.18	0.15	72	5.4	3	62.52	18.76	
11B-Case-12	34.60	2.16	700.00	65.39	0.18	0.15	72	5.4	3	72.24	21.44	
11B-Case-13	34.60	2.16	800.00	74.73	0.18	0.15	72	5.4	3	81.91	24.09	
11B-Case-14	34.60	2.16	900.00	84.07	0.18	0.15	72	5.4	3	91.54	26.71	
11B-Case-15	34.60	2.16	1000.00	93.41	0.18	0.15	72	5.4	3	101.14	29.32	
11B-Case-16	34.60	2.16	2000.00		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11B-Case-17	34.60	2.16	3000.00		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11B-Case-18	34.60	2.16	4000.00		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11B-Case-19	34.60	2.16	5000.00		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11B-Case-20	34.60	2.16	10000.00		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…

Modified Concentration on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	60.69	1.57	0.00		0.22	0.16	72	3.4	15			UNKNOWN ERROR OCCURED DURING MEP
11c-Case-2	60.69	1.57	10.00	1.64	0.22	0.16	72	3.4	15	3.35	1.83	
11c-Case-3	60.69	1.57	20.00	3.28	0.22	0.16	72	3.4	15	5.57	2.71	
11c-Case-4	60.69	1.57	40.00	6.55	0.22	0.16	72	3.4	15	9.64	4.20	
11c-Case-5	60.69	1.57	80.00	13.11	0.22	0.16	72	3.4	15	17.25	6.83	
11c-Case-6	60.69	1.57	100.00	16.39	0.22	0.16	72	3.4	15	20.92	8.06	
11c-Case-7	60.69	1.57	200.00	32.77	0.22	0.16	72	3.4	15	38.69	13.81	
11c-Case-8	60.69	1.57	300.00	49.16	0.22	0.16	72	3.4	15	55.92	19.21	
11c-Case-9	60.69	1.57	400.00	65.54	0.22	0.16	72	3.4	15	72.84	24.43	
11c-Case-10	60.69	1.57	500.00	81.93	0.22	0.16	72	3.4	15	89.57	29.52	
11c-Case-11	60.69	1.57	600.00	98.31	0.22	0.16	72	3.4	15	106.16	34.52	
11c-Case-12	60.69	1.57	700.00	114.70	0.22	0.16	72	3.4	15	122.63	39.45	
11c-Case-13	60.69	1.57	800.00	131.09	0.22	0.16	72	3.4	15	139.01	44.32	
11c-Case-14	60.69	1.57	900.00	147.47	0.22	0.16	72	3.4	15	155.32	49.15	
11c-Case-15	60.69	1.57	1000.00	163.86	0.22	0.16	72	3.4	15	171.56	53.93	
11c-Case-16	60.69	1.57	2000.00		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11c-Case-17	60.69	1.57	3000.00		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11c-Case-18	60.69	1.57	4000.00		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11c-Case-19	60.69	1.57	5000.00		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11c-Case-20	60.69	1.57	10000.00		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…

Table J.2 – Detailed Data for Modification of d35

Modified d_{35} on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
LF-11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
LF-11A-Case-1	53.54	1.48	392.48	56.73	0.2	0.001	72	3.1	15	104.78	53.66	
LF-11A-Case-2	53.54	1.48	392.48	56.73	0.2	0.002	72	3.1	15	104.78	53.66	
LF-11A-Case-3	53.54	1.48	392.48	56.73	0.2	0.004	72	3.1	15	104.78	53.66	
LF-11A-Case-4	53.54	1.48	392.48	56.73	0.2	0.016	72	3.1	15	104.78	53.66	
LF-11A-Case-5	53.54	1.48	392.48	56.73	0.2	0.0625	72	3.1	15	90.65	48.63	
LF-11A-Case-6	53.54	1.48	392.48	56.73	0.2	0.1	72	3.1	15	74.47	35.56	
LF-11A-Case-7	53.54	1.48	392.48	56.73	0.2	0.12	72	3.1	15	68.82	30.78	
LF-11A-Case-8	53.54	1.48	392.48	56.73	0.2	0.125	72	3.1	15	67.71	29.85	
LF-11A-Case-9	53.54	1.48	392.48	56.73	0.2	0.2	72	3.1	15	57.87	21.88	
LF-11A-Case-10	53.54	1.48	392.48		0.2	0.25	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-11	53.54	1.48	392.48		0.2	0.3	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-12	53.54	1.48	392.48		0.2	0.4	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-13	53.54	1.48	392.48		0.2	0.5	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-14	53.54	1.48	392.48		0.2	0.6	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-15	53.54	1.48	392.48		0.2	0.7	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-16	53.54	1.48	392.48		0.2	0.8	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-17	53.54	1.48	392.48		0.2	0.9	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-18	53.54	1.48	392.48		0.2	1	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-19	53.54	1.48	392.48		0.2	2	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-20	53.54	1.48	392.48		0.2	3	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified d35 on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
LF-11B-Initial	34.5975	2.16	256	23.91	0.180	0.15	72	5.4	3	28.46	9.19	
LF-11B-Case-1	34.5975	2.16	256	23.91	0.180	0.001	72	5.4	3	42.28	13.37	
LF-11B-Case-2	34.5975	2.16	256	23.91	0.180	0.002	72	5.4	3	42.28	13.37	
LF-11B-Case-3	34.5975	2.16	256	23.91	0.180	0.004	72	5.4	3	42.28	13.37	
LF-11B-Case-4	34.5975	2.16	256	23.91	0.180	0.016	72	5.4	3	42.28	13.37	
LF-11B-Case-5	34.5975	2.16	256	23.91	0.180	0.0625	72	5.4	3	35.53	11.92	
LF-11B-Case-6	34.5975	2.16	256	23.91	0.180	0.1	72	5.4	3	31.28	10.49	
LF-11B-Case-7	34.5975	2.16	256	23.91	0.180	0.12	72	5.4	3	29.91	9.92	
LF-11B-Case-8	34.5975	2.16	256	23.91	0.180	0.125	72	5.4	3	29.63	9.80	
LF-11B-Case-9	34.5975	2.16	256	23.91	0.180	0.2	72	5.4	3	26.86	8.12	
LF-11B-Case-10	34.5975	2.16	256	23.91	0.180	0.25	72	5.4	3	25.81	7.46	
LF-11B-Case-11	34.5975	2.16	256		0.180	0.3	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
LF-11B-Case-12	34.5975	2.16	256		0.180	0.4	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
LF-11B-Case-13	34.5975	2.16	256		0.180	0.5	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
LF-11B-Case-14	34.5975	2.16	256		0.180	0.6	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11B-Case-15	34.5975	2.16	256		0.180	0.7	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11B-Case-16	34.5975	2.16	256		0.180	0.8	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11B-Case-17	34.5975	2.16	256		0.180	0.9	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11B-Case-18	34.5975	2.16	256		0.180	1	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11B-Case-19	34.5975	2.16	256		0.180	2	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11B-Case-20	34.5975	2.16	256		0.180	3	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified d_{35} on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
LF-11C-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
LF-11C-Case-1	60.69	1.57	255.38	41.85	0.22	0.001	72	3.4	15	92.19	31.66	
LF-11C-Case-2	60.69	1.57	255.38	41.85	0.22	0.002	72	3.4	15	92.19	31.66	
LF-11C-Case-3	60.69	1.57	255.38	41.85	0.22	0.004	72	3.4	15	92.19	31.66	
LF-11C-Case-4	60.69	1.57	255.38	41.85	0.22	0.016	72	3.4	15	92.19	31.66	
LF-11C-Case-5	60.69	1.57	255.38	41.85	0.22	0.0625	72	3.4	15	69.64	26.32	
LF-11C-Case-6	60.69	1.57	255.38	41.85	0.22	0.1	72	3.4	15	56.68	21.35	
LF-11C-Case-7	60.69	1.57	255.38	41.85	0.22	0.12	72	3.4	15	52.95	19.60	
LF-11C-Case-8	60.69	1.57	255.38	41.85	0.22	0.125	72	3.4	15	52.22	19.24	
LF-11C-Case-9	60.69	1.57	255.38	41.85	0.22	0.2	72	3.4	15	45.35	14.80	
LF-11C-Case-10	60.69	1.57	255.38		0.22	0.25	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
LF-11C-Case-11	60.69	1.57	255.38		0.22	0.3	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
LF-11C-Case-12	60.69	1.57	255.38		0.22	0.4	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
LF-11C-Case-13	60.69	1.57	255.38		0.22	0.5	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11C-Case-14	60.69	1.57	255.38		0.22	0.6	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11C-Case-15	60.69	1.57	255.38		0.22	0.7	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11C-Case-16	60.69	1.57	255.38		0.22	0.8	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11C-Case-17	60.69	1.57	255.38		0.22	0.9	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11C-Case-18	60.69	1.57	255.38		0.22	1	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11C-Case-19	60.69	1.57	255.38		0.22	2	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11C-Case-20	60.69	1.57	255.38		0.22	3	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Table J.3 – Detailed Data for Modification of d65

Modified d_{65} on Section 11A-48 to 63												
Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
LF-11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
LF-11A-Case-1	53.54	1.48	392.48		0.001	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-2	53.54	1.48	392.48		0.002	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-3	53.54	1.48	392.48		0.004	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
LF-11A-Case-4	53.54	1.48	392.48		0.016	0.15	72	3.1	15			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
LF-11A-Case-5	53.54	1.48	392.48	56.73	0.0625	0.15	72	3.1	15	58.96	22.77	
LF-11A-Case-6	53.54	1.48	392.48	56.73	0.125	0.15	72	3.1	15	61.56	24.82	
LF-11A-Case-7	53.54	1.48	392.48	56.73	0.25	0.15	72	3.1	15	64.09	26.87	
LF-11A-Case-8	53.54	1.48	392.48	56.73	0.3	0.15	72	3.1	15	64.77	27.44	
LF-11A-Case-9	53.54	1.48	392.48	56.73	0.4	0.15	72	3.1	15	65.85	28.33	
LF-11A-Case-10	53.54	1.48	392.48	56.73	0.5	0.15	72	3.1	15	66.65	29.00	
LF-11A-Case-11	53.54	1.48	392.48	56.73	0.6	0.15	72	3.1	15	67.32	29.57	
LF-11A-Case-12	53.54	1.48	392.48	56.73	0.7	0.15	72	3.1	15	67.85	30.02	
LF-11A-Case-13	53.54	1.48	392.48	56.73	0.8	0.15	72	3.1	15	68.28	30.39	
LF-11A-Case-14	53.54	1.48	392.48	56.73	0.9	0.15	72	3.1	15	68.66	30.72	
LF-11A-Case-15	53.54	1.48	392.48	56.73	1	0.15	72	3.1	15	68.95	30.97	
LF-11A-Case-16	53.54	1.48	392.48	56.73	1.5	0.15	72	3.1	15	70.10	31.97	
LF-11A-Case-17	53.54	1.48	392.48	56.73	2	0.15	72	3.1	15	70.84	32.64	
LF-11A-Case-18	53.54	1.48	392.48	56.73	2.5	0.15	72	3.1	15	72.34	33.54	
LF-11A-Case-19	53.54	1.48	392.48	56.73	4	0.15	72	3.1	15	73.83	34.88	
LF-11A-Case-20	53.54	1.48	392.48	56.73	8	0.15	72	3.1	15	75.92	36.79	

Modified d65 on Section 11B-42.5 to 45.5												
Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
LF-11B-Initial	34.5975	2.16	256	23.91	0.180	0.150	72	5.4	3	28.46	9.19	
LF-11B-Case-1	34.5975	2.16	256		0.001	0.150	72	5.4	3			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
LF-11B-Case-2	34.5975	2.16	256		0.002	0.150	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
LF-11B-Case-3	34.5975	2.16	256		0.004	0.150	72	5.4	3			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
LF-11B-Case-4	34.5975	2.16	256		0.016	0.150	72	5.4	3			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
LF-11B-Case-5	34.5975	2.16	256	23.91	0.063	0.150	72	5.4	3	27.45	8.51	
LF-11B-Case-6	34.5975	2.16	256	23.91	0.125	0.150	72	5.4	3	28.13	8.96	
LF-11B-Case-7	34.5975	2.16	256	23.91	0.250	0.150	72	5.4	3	28.73	9.37	
LF-11B-Case-8	34.5975	2.16	256	23.91	0.300	0.150	72	5.4	3	28.95	9.49	
LF-11B-Case-9	34.5975	2.16	256	23.91	0.400	0.150	72	5.4	3	29.14	9.63	
LF-11B-Case-10	34.5975	2.16	256	23.91	0.500	0.150	72	5.4	3	29.26	9.71	
LF-11B-Case-11	34.5975	2.16	256	23.91	0.600	0.150	72	5.4	3	29.35	9.77	
LF-11B-Case-12	34.5975	2.16	256	23.91	0.700	0.150	72	5.4	3	29.40	9.81	
LF-11B-Case-13	34.5975	2.16	256	23.91	0.800	0.150	72	5.4	3	29.43	9.84	
LF-11B-Case-14	34.5975	2.16	256	23.91	0.900	0.150	72	5.4	3	29.45	9.86	
LF-11B-Case-15	34.5975	2.16	256	23.91	1.000	0.150	72	5.4	3	29.47	9.87	
LF-11B-Case-16	34.5975	2.16	256	23.91	1.500	0.150	72	5.4	3	29.51	9.90	
LF-11B-Case-17	34.5975	2.16	256	23.91	2.000	0.150	72	5.4	3	29.54	9.93	
LF-11B-Case-18	34.5975	2.16	256	23.91	2.500	0.150	72	5.4	3	29.57	9.95	
LF-11B-Case-19	34.5975	2.16	256	23.91	4.000	0.150	72	5.4	3	29.83	10.05	
LF-11B-Case-20	34.5975	2.16	256	23.91	8.000	0.150	72	5.4	3	29.77	10.02	

Modified d_{65} on Section 11C -48 to 63												
Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
LF-11C-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
LF-11C-Case-1	60.69	1.57	255.38		0.001	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
LF-11C-Case-2	60.69	1.57	255.38		0.002	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
LF-11C-Case-3	60.69	1.57	255.38		0.004	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
LF-11C-Case-4	60.69	1.57	255.38		0.016	0.16	72	3.4	15			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
LF-11C-Case-5	60.69	1.57	255.38	41.85	0.0625	0.16	72	3.4	15	45.27	14.76	
LF-11C-Case-6	60.69	1.57	255.38	41.85	0.125	0.16	72	3.4	15	46.95	15.90	
LF-11C-Case-7	60.69	1.57	255.38	41.85	0.25	0.16	72	3.4	15	48.58	17.05	
LF-11C-Case-8	60.69	1.57	255.38	41.85	0.3	0.16	72	3.4	15	49.01	17.36	
LF-11C-Case-9	60.69	1.57	255.38	41.85	0.4	0.16	72	3.4	15	49.67	17.83	
LF-11C-Case-10	60.69	1.57	255.38	41.85	0.5	0.16	72	3.4	15	50.17	18.20	
LF-11C-Case-11	60.69	1.57	255.38	41.85	0.6	0.16	72	3.4	15	50.55	18.48	
LF-11C-Case-12	60.69	1.57	255.38	41.85	0.7	0.16	72	3.4	15	50.87	18.71	
LF-11C-Case-13	60.69	1.57	255.38	41.85	0.8	0.16	72	3.4	15	51.11	18.90	
LF-11C-Case-14	60.69	1.57	255.38	41.85	0.9	0.16	72	3.4	15	51.32	19.06	
LF-11C-Case-15	60.69	1.57	255.38	41.85	1	0.16	72	3.4	15	51.49	19.19	
LF-11C-Case-16	60.69	1.57	255.38	41.85	1.5	0.16	72	3.4	15	52.06	19.63	
LF-11C-Case-17	60.69	1.57	255.38		2	0.16	72	3.4	15			FAILED TO CONVERGE TO Z DURING MEP
LF-11C-Case-18	60.69	1.57	255.38	41.85	2.5	0.16	72	3.4	15	53.40	20.40	
LF-11C-Case-19	60.69	1.57	255.38	41.85	4	0.16	72	3.4	15	54.08	20.94	
LF-11C-Case-20	60.69	1.57	255.38	41.85	8	0.16	72	3.4	15	54.88	21.58	

Table J.4 – Detailed Data for Modification of Water Temperature

Modified Temperature on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	53.54	1.48	392.48		0.2	0.15	0	3.1	15			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
11A-Case-2	53.54	1.48	392.48		0.2	0.15	5	3.1	15			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
11A-Case-3	53.54	1.48	392.48		0.2	0.15	10	3.1	15			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
11A-Case-4	53.54	1.48	392.48	56.73	0.2	0.15	20	3.1	15	62.04	24.98	
11A-Case-5	53.54	1.48	392.48	56.73	0.2	0.15	30	3.1	15	62.69	25.52	
11A-Case-6	53.54	1.48	392.48	56.73	0.2	0.15	40	3.1	15	62.96	25.78	
11A-Case-7	53.54	1.48	392.48	56.73	0.2	0.15	50	3.1	15	63.11	25.95	
11A-Case-8	53.54	1.48	392.48	56.73	0.2	0.15	60	3.1	15	63.19	26.08	
11A-Case-9	53.54	1.48	392.48	56.73	0.2	0.15	70	3.1	15	63.25	26.18	
11A-Case-10	53.54	1.48	392.48	56.73	0.2	0.15	80	3.1	15	63.28	26.25	
11A-Case-11	53.54	1.48	392.48	56.73	0.2	0.15	90	3.1	15	63.29	26.31	
11A-Case-12	53.54	1.48	392.48	56.73	0.2	0.15	100	3.1	15	63.30	26.37	
11A-Case-13	53.54	1.48	392.48	56.73	0.2	0.15	110	3.1	15	63.28	26.40	
11A-Case-14	53.54	1.48	392.48	56.73	0.2	0.15	120	3.1	15	63.28	26.44	
11A-Case-15	53.54	1.48	392.48	56.73	0.2	0.15	130	3.1	15	63.27	26.47	
11A-Case-16	53.54	1.48	392.48	56.73	0.2	0.15	140	3.1	15	63.25	26.49	
11A-Case-17	53.54	1.48	392.48	56.73	0.2	0.15	150	3.1	15	63.22	26.51	
11A-Case-18	53.54	1.48	392.48	56.73	0.2	0.15	160	3.1	15	63.20	26.52	
11A-Case-19	53.54	1.48	392.48	56.73	0.2	0.15	175	3.1	15	63.18	26.55	
11A-Case-20	53.54	1.48	392.48	56.73	0.2	0.15	200	3.1	15	63.14	26.58	

Modified Temperature on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	34.60	2.16	256.00		0.18	0.15	0	5.4	3			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
11B-Case-2	34.60	2.16	256.00		0.18	0.15	5	5.4	3			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
11B-Case-3	34.60	2.16	256.00	23.91	0.18	0.15	10	5.4	3	27.53	8.15	
11B-Case-4	34.60	2.16	256.00	23.91	0.18	0.15	20	5.4	3	28.56	8.83	
11B-Case-5	34.60	2.16	256.00	23.91	0.18	0.15	30	5.4	3	28.63	8.97	
11B-Case-6	34.60	2.16	256.00	23.91	0.18	0.15	40	5.4	3	28.63	9.06	
11B-Case-7	34.60	2.16	256.00	23.91	0.18	0.15	50	5.4	3	28.61	9.12	
11B-Case-8	34.60	2.16	256.00	23.91	0.18	0.15	60	5.4	3	28.49	9.14	
11B-Case-9	34.60	2.16	256.00	23.91	0.18	0.15	70	5.4	3	28.46	9.18	
11B-Case-10	34.60	2.16	256.00	23.91	0.18	0.15	80	5.4	3	28.43	9.21	
11B-Case-11	34.60	2.16	256.00	23.91	0.18	0.15	90	5.4	3	28.40	9.23	
11B-Case-12	34.60	2.16	256.00	23.91	0.18	0.15	100	5.4	3	28.37	9.24	
11B-Case-13	34.60	2.16	256.00	23.91	0.18	0.15	110	5.4	3	28.35	9.26	
11B-Case-14	34.60	2.16	256.00	23.91	0.18	0.15	120	5.4	3	28.32	9.27	
11B-Case-15	34.60	2.16	256.00	23.91	0.18	0.15	130	5.4	3	28.30	9.27	
11B-Case-16	34.60	2.16	256.00	23.91	0.18	0.15	140	5.4	3	28.27	9.28	
11B-Case-17	34.60	2.16	256.00	23.91	0.18	0.15	150	5.4	3	28.26	9.28	
11B-Case-18	34.60	2.16	256.00	23.91	0.18	0.15	160	5.4	3	28.24	9.29	
11B-Case-19	34.60	2.16	256.00	23.91	0.18	0.15	175	5.4	3	28.21	9.29	
11B-Case-20	34.60	2.16	256.00	23.91	0.18	0.15	200	5.4	3	28.17	9.29	

Modified Temperature on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	60.69	1.57	255.38		0.22	0.16	0	3.4	15			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
11c-Case-2	60.69	1.57	255.38		0.22	0.16	5	3.4	15			UNKNOWN ERROR... ATTEMPTING TO CONTINUE
11c-Case-3	60.69	1.57	255.38	41.85	0.22	0.16	10	3.4	15	45.43	14.29	
11c-Case-4	60.69	1.57	255.38	41.85	0.22	0.16	20	3.4	15	48.07	16.11	
11c-Case-5	60.69	1.57	255.38	41.85	0.22	0.16	30	3.4	15	48.28	16.39	
11c-Case-6	60.69	1.57	255.38	41.85	0.22	0.16	40	3.4	15	48.32	16.55	
11c-Case-7	60.69	1.57	255.38	41.85	0.22	0.16	50	3.4	15	48.33	16.67	
11c-Case-8	60.69	1.57	255.38	41.85	0.22	0.16	60	3.4	15	48.31	16.76	
11c-Case-9	60.69	1.57	255.38	41.85	0.22	0.16	70	3.4	15	48.29	16.82	
11c-Case-10	60.69	1.57	255.38	41.85	0.22	0.16	80	3.4	15	48.26	16.87	
11c-Case-11	60.69	1.57	255.38	41.85	0.22	0.16	90	3.4	15	48.22	16.91	
11c-Case-12	60.69	1.57	255.38	41.85	0.22	0.16	100	3.4	15	48.19	16.94	
11c-Case-13	60.69	1.57	255.38	41.85	0.22	0.16	110	3.4	15	48.16	16.97	
11c-Case-14	60.69	1.57	255.38	41.85	0.22	0.16	120	3.4	15	48.12	16.99	
11c-Case-15	60.69	1.57	255.38	41.85	0.22	0.16	130	3.4	15	48.09	17.00	
11c-Case-16	60.69	1.57	255.38	41.85	0.22	0.16	140	3.4	15	48.06	17.01	
11c-Case-17	60.69	1.57	255.38	41.85	0.22	0.16	150	3.4	15	48.03	17.02	
11c-Case-18	60.69	1.57	255.38	41.85	0.22	0.16	160	3.4	15	48.01	17.03	
11c-Case-19	60.69	1.57	255.38	41.85	0.22	0.16	175	3.4	15	47.97	17.03	
11c-Case-20	60.69	1.57	255.38	41.85	0.22	0.16	200	3.4	15	47.91	17.04	

Table J.5 – Detailed Data for Modification of Flow Depth

Modified Depth on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	53.54	1.48	392.48		0.2	0.15	72	0	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-2	53.54	1.48	392.48	56.73	0.2	0.15	72	0.5	15	63.26	27.11	
11A-Case-3	53.54	1.48	392.48	56.73	0.2	0.15	72	1	15	63.24	26.73	
11A-Case-4	53.54	1.48	392.48	56.73	0.2	0.15	72	2	15	63.25	26.40	
11A-Case-5	53.54	1.48	392.48	56.73	0.2	0.15	72	3	15	63.26	26.21	
11A-Case-6	53.54	1.48	392.48	56.73	0.2	0.15	72	4	15	63.27	26.08	
11A-Case-7	53.54	1.48	392.48	56.73	0.2	0.15	72	5	15	63.27	25.99	
11A-Case-8	53.54	1.48	392.48	56.73	0.2	0.15	72	6	15	63.27	25.90	
11A-Case-9	53.54	1.48	392.48	56.73	0.2	0.15	72	7	15	63.00	25.74	
11A-Case-10	53.54	1.48	392.48	56.73	0.2	0.15	72	8	15	62.99	25.68	
11A-Case-11	53.54	1.48	392.48	56.73	0.2	0.15	72	9	15	63.00	25.63	
11A-Case-12	53.54	1.48	392.48	56.73	0.2	0.15	72	10	15	63.00	25.59	
11A-Case-13	53.54	1.48	392.48	56.73	0.2	0.15	72	15	15	62.99	25.42	
11A-Case-14	53.54	1.48	392.48	56.73	0.2	0.15	72	20	15	62.97	25.29	
11A-Case-15	53.54	1.48	392.48	56.73	0.2	0.15	72	25	15	62.95	25.19	
11A-Case-16	53.54	1.48	392.48	56.73	0.2	0.15	72	30	15	62.93	25.11	
11A-Case-17	53.54	1.48	392.48	56.73	0.2	0.15	72	40	15	62.89	24.97	
11A-Case-18	53.54	1.48	392.48		0.2	0.15	72	50	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-19	53.54	1.48	392.48		0.2	0.15	72	75	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-20	53.54	1.48	392.48		0.2	0.15	72	100	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified Depth on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	34.60	2.16	256.00		0.18	0.15	72	0	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-2	34.60	2.16	256.00		0.18	0.15	72	0.5	3			FAILED TO CONVERGE TO Z DURING MEP
11B-Case-3	34.60	2.16	256.00	23.91	0.18	0.15	72	1	3	27.36	8.73	
11B-Case-4	34.60	2.16	256.00	23.91	0.18	0.15	72	2	3	27.89	8.96	
11B-Case-5	34.60	2.16	256.00	23.91	0.18	0.15	72	3	3	28.17	9.07	
11B-Case-6	34.60	2.16	256.00	23.91	0.18	0.15	72	4	3	28.35	9.14	
11B-Case-7	34.60	2.16	256.00	23.91	0.18	0.15	72	5	3	28.41	9.17	
11B-Case-8	34.60	2.16	256.00	23.91	0.18	0.15	72	6	3	28.52	9.21	
11B-Case-9	34.60	2.16	256.00	23.91	0.18	0.15	72	7	3	28.61	9.23	
11B-Case-10	34.60	2.16	256.00	23.91	0.18	0.15	72	8	3	28.69	9.26	
11B-Case-11	34.60	2.16	256.00	23.91	0.18	0.15	72	9	3	28.75	9.28	
11B-Case-12	34.60	2.16	256.00	23.91	0.18	0.15	72	10	3	28.81	9.29	
11B-Case-13	34.60	2.16	256.00	23.91	0.18	0.15	72	15	3	29.02	9.35	
11B-Case-14	34.60	2.16	256.00	23.91	0.18	0.15	72	20	3	29.16	9.38	
11B-Case-15	34.60	2.16	256.00	23.91	0.18	0.15	72	25	3	29.26	9.40	
11B-Case-16	34.60	2.16	256.00	23.91	0.18	0.15	72	30	3	29.35	9.42	
11B-Case-17	34.60	2.16	256.00	23.91	0.18	0.15	72	40	3	29.47	9.44	
11B-Case-18	34.60	2.16	256.00	23.91	0.18	0.15	72	50	3	29.57	9.46	
11B-Case-19	34.60	2.16	256.00	23.91	0.18	0.15	72	75	3	29.73	9.48	
11B-Case-20	34.60	2.16	256.00	23.91	0.18	0.15	72	100	3	29.84	9.50	

Modified Depth on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	60.69	1.57	255.38		0.22	0.16	72	0	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-2	60.69	1.57	255.38	41.85	0.22	0.16	72	0.5	15	47.22	16.79	
11c-Case-3	60.69	1.57	255.38	41.85	0.22	0.16	72	1	15	47.67	16.85	
11c-Case-4	60.69	1.57	255.38	41.85	0.22	0.16	72	2	15	48.04	16.85	
11c-Case-5	60.69	1.57	255.38	41.85	0.22	0.16	72	3	15	48.22	16.84	
11c-Case-6	60.69	1.57	255.38	41.85	0.22	0.16	72	4	15	48.35	16.82	
11c-Case-7	60.69	1.57	255.38	41.85	0.22	0.16	72	5	15	48.44	16.81	
11c-Case-8	60.69	1.57	255.38	41.85	0.22	0.16	72	6	15	48.32	16.74	
11c-Case-9	60.69	1.57	255.38	41.85	0.22	0.16	72	7	15	48.38	16.72	
11c-Case-10	60.69	1.57	255.38	41.85	0.22	0.16	72	8	15	48.43	16.71	
11c-Case-11	60.69	1.57	255.38	41.85	0.22	0.16	72	9	15	48.47	16.70	
11c-Case-12	60.69	1.57	255.38	41.85	0.22	0.16	72	10	15	48.50	16.69	
11c-Case-13	60.69	1.57	255.38	41.85	0.22	0.16	72	15	15	48.62	16.64	
11c-Case-14	60.69	1.57	255.38	41.85	0.22	0.16	72	20	15	48.70	16.60	
11c-Case-15	60.69	1.57	255.38	41.85	0.22	0.16	72	25	15	48.75	16.57	
11c-Case-16	60.69	1.57	255.38	41.85	0.22	0.16	72	30	15	48.78	16.54	
11c-Case-17	60.69	1.57	255.38	41.85	0.22	0.16	72	40	15	48.83	16.50	
11c-Case-18	60.69	1.57	255.38	41.85	0.22	0.16	72	50	15	48.86	16.45	
11c-Case-19	60.69	1.57	255.38		0.22	0.16	72	75	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-20	60.69	1.57	255.38		0.22	0.16	72	100	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING

Table J.6 – Detailed Data for Modification of Discharge

Table 1 - Modified Flow on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Error
11A-Initial	53.535	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	0	1.48	392.48		0.2	0.15	72	3.1	15			UNKNOWN ERROR OCCURED DURING MEP
11A-Case-2	1	1.48	392.48	1.06	0.2	0.15	72	3.1	15	3.16	2.28	
11A-Case-3	2	1.48	392.48	2.12	0.2	0.15	72	3.1	15	4.72	3.07	
11A-Case-4	3	1.48	392.48	3.18	0.2	0.15	72	3.1	15	6.15	3.75	
11A-Case-5	4	1.48	392.48	4.24	0.2	0.15	72	3.1	15	7.51	4.37	
11A-Case-6	5	1.48	392.48	5.30	0.2	0.15	72	3.1	15	8.82	4.96	
11A-Case-7	10	1.48	392.48	10.60	0.2	0.15	72	3.1	15	15.05	7.63	
11A-Case-8	20	1.48	392.48	21.19	0.2	0.15	72	3.1	15	26.68	12.32	
11A-Case-9	40	1.48	392.48	42.39	0.2	0.15	72	3.1	15	48.76	20.79	
11A-Case-10	60	1.48	392.48	63.58	0.2	0.15	72	3.1	15	70.10	28.71	
11A-Case-11	80	1.48	392.48	84.78	0.2	0.15	72	3.1	15	91.07	36.35	
11A-Case-12	100	1.48	392.48	105.97	0.2	0.15	72	3.1	15	111.78	43.79	
11A-Case-13	150	1.48	392.48	158.95	0.2	0.15	72	3.1	15	162.85	61.86	
11A-Case-14	200	1.48	392.48	211.94	0.2	0.15	72	3.1	15	213.26	79.42	
11A-Case-15	250	1.48	392.48	264.92	0.2	0.15	72	3.1	15	263.25	96.66	
11A-Case-16	300	1.48	392.48	317.91	0.2	0.15	72	3.1	15	312.94	113.66	
11A-Case-17	350	1.48	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-18	400	1.48	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-19	500	1.48	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-20	1000	1.48	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified Flow on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Error
11B-Initial	34.5975	2.16	256	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	0	2.16	256					5.4	3			UNKNOWN ERROR OCCURED DURING MEP
11B-Case-2	1	2.16	256	0.69	0.18	0.15	72	5.4	3	1.62	0.90	
11B-Case-3	2	2.16	256	1.38	0.18	0.15	72	5.4	3	2.62	1.27	
11B-Case-4	3	2.16	256	2.07	0.18	0.15	72	5.4	3	3.56	1.61	
11B-Case-5	4	2.16	256	2.76	0.18	0.15	72	5.4	3	4.45	1.92	
11B-Case-6	5	2.16	256	3.46	0.18	0.15	72	5.4	3	5.32	2.21	
11B-Case-7	10	2.16	256	6.91	0.18	0.15	72	5.4	3	9.49	3.55	
11B-Case-8	20	2.16	256	13.82	0.18	0.15	72	5.4	3	17.37	5.95	
11B-Case-9	40	2.16	256	27.65	0.18	0.15	72	5.4	3	32.49	10.34	
11B-Case-10	60	2.16	256	41.47	0.18	0.15	72	5.4	3	47.22	14.50	
11B-Case-11	80	2.16	256	55.30	0.18	0.15	72	5.4	3	61.73	18.54	
11B-Case-12	100	2.16	256	69.12	0.18	0.15	72	5.4	3	76.11	22.50	
11B-Case-13	150	2.16	256	103.68	0.18	0.15	72	5.4	3	111.65	32.17	
11B-Case-14	200	2.16	256	138.24	0.18	0.15	72	5.4	3	146.82	41.62	
11B-Case-15	250	2.16	256		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-16	300	2.16	256		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-17	350	2.16	256		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-18	400	2.16	256		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-19	500	2.16	256		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-20	1000	2.16	256		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...

Modified Flow on Section 11C-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Error
11c-Initial	60.688	1.57	255.3846	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	0	1.57						3.4	15			UNKNOWN ERROR OCCURED DURING MEP
11c-Case-2	1	1.57	255.3846	0.69	0.22	0.16	72	3.4	15	1.90	1.20	
11c-Case-3	2	1.57	255.3846	1.38	0.22	0.16	72	3.4	15	2.97	1.67	
11c-Case-4	3	1.57	255.3846	2.07	0.22	0.16	72	3.4	15	3.95	2.08	
11c-Case-5	4	1.57	255.3846	2.76	0.22	0.16	72	3.4	15	4.89	2.45	
11c-Case-6	5	1.57	255.3846	3.45	0.22	0.16	72	3.4	15	5.78	2.79	
11c-Case-7	10	1.57	255.3846	6.90	0.22	0.16	72	3.4	15	10.04	4.35	
11c-Case-8	20	1.57	255.3846	13.79	0.22	0.16	72	3.4	15	18.02	7.09	
11c-Case-9	40	1.57	255.3846	27.58	0.22	0.16	72	3.4	15	33.15	12.04	
11c-Case-10	60	1.57	255.3846	41.37	0.22	0.16	72	3.4	15	47.78	16.68	
11c-Case-11	80	1.57	255.3846	55.16	0.22	0.16	72	3.4	15	62.15	21.14	
11c-Case-12	100	1.57	255.3846	68.95	0.22	0.16	72	3.4	15	76.34	25.50	
11c-Case-13	150	1.57	255.3846	103.43	0.22	0.16	72	3.4	15	111.31	36.07	
11c-Case-14	200	1.57	255.3846	137.91	0.22	0.16	72	3.4	15	145.81	46.34	
11c-Case-15	250	1.57	255.3846	172.38	0.22	0.16	72	3.4	15	179.99	56.41	
11c-Case-16	300	1.57	255.3846	206.86	0.22	0.16	72	3.4	15	213.95	66.34	
11c-Case-17	350	1.57	255.3846		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-18	400	1.57	255.3846		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-19	500	1.57	255.3846		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-20	1000	1.57	255.3846		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...

Table J.7 – Detailed Data for Modification of Velocity

Modified Velocity on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	53.54	0.00	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-2	53.54	0.50	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-3	53.54	1.00	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-4	53.54	1.50	392.48	56.73	0.2	0.15	72	3.1	15	63.98	26.78	
11A-Case-5	53.54	2.00	392.48	56.73	0.2	0.15	72	3.1	15	82.80	42.78	
11A-Case-6	53.54	3.00	392.48	56.73	0.2	0.15	72	3.1	15	130.02	85.57	
11A-Case-7	53.54	4.00	392.48	56.73	0.2	0.15	72	3.1	15	178.79	131.29	
11A-Case-8	53.54	5.00	392.48	56.73	0.2	0.15	72	3.1	15	231.90	181.71	
11A-Case-9	53.54	6.00	392.48	56.73	0.2	0.15	72	3.1	15	289.63	236.90	
11A-Case-10	53.54	7.00	392.48	56.73	0.2	0.15	72	3.1	15	352.09	297.03	
11A-Case-11	53.54	8.00	392.48	56.73	0.2	0.15	72	3.1	15	406.83	351.18	
11A-Case-12	53.54	9.00	392.48	56.73	0.2	0.15	72	3.1	15	477.54	420.02	
11A-Case-13	53.54	10.00	392.48	56.73	0.2	0.15	72	3.1	15	553.31	494.02	
11A-Case-14	53.54	11.00	392.48	56.73	0.2	0.15	72	3.1	15	635.71	574.17	
11A-Case-15	53.54	12.00	392.48	56.73	0.2	0.15	72	3.1	15	721.53	658.39	
11A-Case-16	53.54	14.00	392.48	56.73	0.2	0.15	72	3.1	15	910.79	843.99	
11A-Case-17	53.54	16.00	392.48	56.73	0.2	0.15	72	3.1	15	1033.47	972.19	
11A-Case-18	53.54	18.00	392.48	56.73	0.2	0.15	72	3.1	15	1255.34	1191.03	
11A-Case-19	53.54	20.00	392.48	56.73	0.2	0.15	72	3.1	15	1752.89	1658.07	
11A-Case-20	53.54	25	392.48	56.73	0.2	0.15	72	3.1	15	2507.58	2404.54	

Modified Velocity on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	34.60	0.00	256.00		0.18	0.15	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-2	34.60	0.50	256.00		0.18	0.15	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-3	34.60	1.00	256.00		0.18	0.15	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-4	34.60	1.50	256.00		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT, NOT CONTINUING
11B-Case-5	34.60	2.00	256.00	23.91	0.18	0.15	72	5.4	3	27.57	8.59	
11B-Case-6	34.60	3.00	256.00	23.91	0.18	0.15	72	5.4	3	33.12	12.51	
11B-Case-7	34.60	4.00	256.00	23.91	0.18	0.15	72	5.4	3	38.05	16.26	
11B-Case-8	34.60	5.00	256.00	23.91	0.18	0.15	72	5.4	3	42.63	19.88	
11B-Case-9	34.60	6.00	256.00	23.91	0.18	0.15	72	5.4	3	47.17	23.56	
11B-Case-10	34.60	7.00	256.00	23.91	0.18	0.15	72	5.4	3	52.08	27.63	
11B-Case-11	34.60	8.00	256.00	23.91	0.18	0.15	72	5.4	3	56.84	31.65	
11B-Case-12	34.60	9.00	256.00	23.91	0.18	0.15	72	5.4	3	61.73	35.84	
11B-Case-13	34.60	10.00	256.00	23.91	0.18	0.15	72	5.4	3	66.71	40.18	
11B-Case-14	34.60	11.00	256.00	23.91	0.18	0.15	72	5.4	3	72.91	45.53	
11B-Case-15	34.60	12.00	256.00	23.91	0.18	0.15	72	5.4	3	78.38	50.57	
11B-Case-16	34.60	14.00	256.00	23.91	0.18	0.15	72	5.4	3	86.59	57.49	
11B-Case-17	34.60	16.00	256.00	23.91	0.18	0.15	72	5.4	3	98.35	68.55	
11B-Case-18	34.60	18.00	256.00	23.91	0.18	0.15	72	5.4	3	118.82	87.24	
11B-Case-19	34.60	20.00	256.00	23.91	0.18	0.15	72	5.4	3	132.07	99.20	
11B-Case-20	34.60	25	256.00	23.91	0.18	0.15	72	5.4	3	199.20	161.71	

Modified Velocity on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	60.69	0.00	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-2	60.69	0.50	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-3	60.69	1.00	255.38		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT, NOT CONTINUING
11c-Case-4	60.69	1.50	255.38	41.85	0.22	0.16	72	3.4	15	46.98	15.92	
11c-Case-5	60.69	2.00	255.38	41.85	0.22	0.16	72	3.4	15	57.43	23.62	
11c-Case-6	60.69	3.00	255.38	41.85	0.22	0.16	72	3.4	15	81.33	43.10	
11c-Case-7	60.69	4.00	255.38	41.85	0.22	0.16	72	3.4	15	104.41	63.09	
11c-Case-8	60.69	5.00	255.38	41.85	0.22	0.16	72	3.4	15	129.25	85.65	
11c-Case-9	60.69	6.00	255.38	41.85	0.22	0.16	72	3.4	15	153.56	107.44	
11c-Case-10	60.69	7.00	255.38	41.85	0.22	0.16	72	3.4	15	179.04	130.52	
11c-Case-11	60.69	8.00	255.38	41.85	0.22	0.16	72	3.4	15	208.28	159.30	
11c-Case-12	60.69	9.00	255.38	41.85	0.22	0.16	72	3.4	15	236.66	185.67	
11c-Case-13	60.69	10.00	255.38	41.85	0.22	0.16	72	3.4	15	266.19	213.29	
11c-Case-14	60.69	11.00	255.38	41.85	0.22	0.16	72	3.4	15	319.34	263.78	
11c-Case-15	60.69	12.00	255.38	41.85	0.22	0.16	72	3.4	15	354.99	297.33	
11c-Case-16	60.69	14.00	255.38	41.85	0.22	0.16	72	3.4	15	585.03	531.90	
11c-Case-17	60.69	16.00	255.38	41.85	0.22	0.16	72	3.4	15	481.26	427.27	
11c-Case-18	60.69	18.00	255.38	41.85	0.22	0.16	72	3.4	15	1720.12	1682.57	
11c-Case-19	60.69	20.00	255.38	41.85	0.22	0.16	72	3.4	15	1970.34	1932.24	
11c-Case-20	60.69	25	255.38	41.85	0.22	0.16	72	3.4	15	2680.58	2640.92	

Table J.8 – Detailed Data for Modification of Width

Modified Width on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	53.54	1.48	392.48		0.2	0.15	72	3.1	0			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-2	53.54	1.48	392.48		0.2	0.15	72	3.1	2.5			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-3	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	5	57.86	21.87	
11A-Case-4	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	10	60.93	24.31	
11A-Case-5	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	20	65.23	27.81	
11A-Case-6	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	25	66.96	29.24	
11A-Case-7	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	30	68.55	30.56	
11A-Case-8	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	35	70.03	31.81	
11A-Case-9	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	40	71.39	32.95	
11A-Case-10	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	45	72.72	34.08	
11A-Case-11	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	50	73.95	35.13	
11A-Case-12	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	60	76.27	37.12	
11A-Case-13	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	70	78.44	39.00	
11A-Case-14	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	80	80.50	40.78	
11A-Case-15	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	90	82.46	42.50	
11A-Case-16	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	100	84.34	44.15	
11A-Case-17	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	250	107.37	64.80	
11A-Case-18	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	500	137.68	92.71	
11A-Case-19	53.54	1.48	392.48		0.2	0.15	72	3.1	1000			FAILED TO CONVERGE TO Z DURING MEP
11A-Case-20	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	2000	270.10	218.60	

Modified Width on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	34.60	2.16	256.00		0.18	0.15	72	5.4	0			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-2	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	2.5	28.01	8.89	
11B-Case-3	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	5	29.93	10.20	
11B-Case-4	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	10	32.64	12.16	
11B-Case-5	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	20	36.55	15.10	
11B-Case-6	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	25	38.17	16.35	
11B-Case-7	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	30	39.72	17.58	
11B-Case-8	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	35	41.11	18.68	
11B-Case-9	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	40	42.42	19.73	
11B-Case-10	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	45	43.66	20.74	
11B-Case-11	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	50	44.86	21.69	
11B-Case-12	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	60	47.11	23.57	
11B-Case-13	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	70	49.23	25.27	
11B-Case-14	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	80	51.25	27.00	
11B-Case-15	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	90	53.46	28.84	
11B-Case-16	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	100	55.34	30.49	
11B-Case-17	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	250	77.33	49.52	
11B-Case-18	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	500	115.45	84.25	
11B-Case-19	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	1000	198.22	160.81	
11B-Case-20	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	2000	217.65	174.82	

Modified Width on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	60.69	1.57	255.38		0.22	0.16	72	3.4	0			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-2	60.69	1.57	255.38		0.22	0.16	72	3.4	2.5			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11c-Case-3	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	5	44.49	14.23	
11c-Case-4	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	10	46.66	15.70	
11c-Case-5	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	20	49.62	17.79	
11c-Case-6	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	25	50.80	18.64	
11c-Case-7	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	30	51.86	19.42	
11c-Case-8	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	35	52.83	20.14	
11c-Case-9	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	40	53.74	20.81	
11c-Case-10	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	45	54.59	21.45	
11c-Case-11	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	50	55.40	22.07	
11c-Case-12	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	60	56.90	23.22	
11c-Case-13	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	70	58.30	24.30	
11c-Case-14	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	80	59.60	25.31	
11c-Case-15	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	90	60.84	26.28	
11c-Case-16	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	100	62.01	27.23	
11c-Case-17	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	250	75.93	38.60	
11c-Case-18	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	500	93.04	53.17	
11c-Case-19	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	1000	120.06	76.88	
11c-Case-20	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	2000	166.27	119.09	

Table J.9 – Detailed Data for Modification of Flow Depth and Discharge

Modified Depth and Flow on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	0.00	1.48	392.48		0.2	0.15	72	0	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-2	11.08	1.48	392.48	11.74	0.2	0.15	72	0.5	15	17.71	9.78	
11A-Case-3	22.15	1.48	392.48	23.47	0.2	0.15	72	1	15	29.70	14.12	
11A-Case-4	44.30	1.48	392.48	46.95	0.2	0.15	72	2	15	53.44	22.76	
11A-Case-5	66.46	1.48	392.48	70.42	0.2	0.15	72	3	15	76.90	31.21	
11A-Case-6	88.61	1.48	392.48	93.90	0.2	0.15	72	4	15	100.14	39.52	
11A-Case-7	110.76	1.48	392.48	117.37	0.2	0.15	72	5	15	123.24	47.72	
11A-Case-8	132.91	1.48	392.48	140.85	0.2	0.15	72	6	15	146.22	55.84	
11A-Case-9	155.07	1.48	392.48	164.32	0.2	0.15	72	7	15	168.34	63.61	
11A-Case-10	177.22	1.48	392.48		0.2	0.15	72	8	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11A-Case-11	199.37	1.48	392.48		0.2	0.15	72	9	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11A-Case-12	221.52	1.48	392.48		0.2	0.15	72	10	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11A-Case-13	332.29	1.48	392.48		0.2	0.15	72	15	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11A-Case-14	443.05	1.48	392.48		0.2	0.15	72	20	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11A-Case-15	553.81	1.48	392.48		0.2	0.15	72	25	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11A-Case-16	664.57	1.48	392.48		0.2	0.15	72	30	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11A-Case-17	886.10	1.48	392.48		0.2	0.15	72	40	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11A-Case-18	1107.62	1.48	392.48		0.2	0.15	72	50	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11A-Case-19	1661.43	1.48	392.48		0.2	0.15	72	75	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11A-Case-20	2220.00	1.48	392.48		0.2	0.15	72	100	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING

Modified Depth and Flow on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	0.00	2.16	256.00		0.18	0.15	72	0	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-2	3.23	2.16	256.00	2.23	0.18	0.15	72	0.5	3	3.66	1.74	
11B-Case-3	6.47	2.16	256.00	4.47	0.18	0.15	72	1	3	6.40	2.63	
11B-Case-4	12.93	2.16	256.00		0.18	0.15	72	2	3			FAILED TO CONVERGE TO Z DURING MEP
11B-Case-5	19.40	2.16	256.00	13.41	0.18	0.15	72	3	3	16.75	5.77	
11B-Case-6	25.87	2.16	256.00	17.88	0.18	0.15	72	4	3	21.79	7.25	
11B-Case-7	32.33	2.16	256.00	22.35	0.18	0.15	72	5	3	26.71	8.68	
11B-Case-8	38.80	2.16	256.00	26.82	0.18	0.15	72	6	3	31.67	10.11	
11B-Case-9	45.27	2.16	256.00	31.29	0.18	0.15	72	7	3	36.59	11.52	
11B-Case-10	51.73	2.16	256.00	35.76	0.18	0.15	72	8	3	41.50	12.92	
11B-Case-11	58.20	2.16	256.00	40.23	0.18	0.15	72	9	3	46.39	14.31	
11B-Case-12	64.67	2.16	256.00	44.70	0.18	0.15	72	10	3	51.26	15.69	
11B-Case-13	97.00	2.16	256.00	67.05	0.18	0.15	72	15	3	75.47	22.50	
11B-Case-14	129.34	2.16	256.00	89.40	0.18	0.15	72	20	3	99.49	29.19	
11B-Case-15	161.67	2.16	256.00		0.18	0.15	72	25	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11B-Case-16	194.00	2.16	256.00		0.18	0.15	72	30	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11B-Case-17	258.67	2.16	256.00		0.18	0.15	72	40	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11B-Case-18	323.34	2.16	256.00		0.18	0.15	72	50	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11B-Case-19	485.01	2.16	256.00		0.18	0.15	72	75	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11B-Case-20	646.68	2.16	256.00		0.18	0.15	72	100	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING

Modified Depth and Flow on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	0.00	1.57	255.38		0.22	0.16	72	0	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-2	11.78	1.57	255.38		0.22	0.16	72	0.5	15			FAILED TO CONVERGE TO Z DURING MEP
11c-Case-3	23.55	1.57	255.38		0.22	0.16	72	1	15			FAILED TO CONVERGE TO Z DURING MEP
11c-Case-4	47.11	1.57	255.38	32.48	0.22	0.16	72	2	15	38.24	13.78	
11c-Case-5	70.66	1.57	255.38	48.72	0.22	0.16	72	3	15	55.40	19.07	
11c-Case-6	94.21	1.57	255.38	64.96	0.22	0.16	72	4	15	72.38	24.27	
11c-Case-7	117.76	1.57	255.38	81.20	0.22	0.16	72	5	15	89.25	29.39	
11c-Case-8	141.32	1.57	255.38	97.44	0.22	0.16	72	6	15	105.62	34.33	
11c-Case-9	164.87	1.57	255.38	113.68	0.22	0.16	72	7	15	122.26	39.33	
11c-Case-10	188.42	1.57	255.38	129.93	0.22	0.16	72	8	15	138.84	44.30	
11c-Case-11	211.98	1.57	255.38		0.22	0.16	72	9	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-12	235.53	1.57	255.38		0.22	0.16	72	10	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-13	353.29	1.57	255.38		0.22	0.16	72	15	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-14	471.06	1.57	255.38		0.22	0.16	72	20	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-15	588.82	1.57	255.38		0.22	0.16	72	25	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-16	706.59	1.57	255.38		0.22	0.16	72	30	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-17	942.12	1.57	255.38		0.22	0.16	72	40	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-18	1177.65	1.57	255.38		0.22	0.16	72	50	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-19	1766.47	1.57	255.38		0.22	0.16	72	75	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-20	2355.00	1.57	255.38		0.22	0.16	72	100	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Table J.10 – Detailed Data for Modification of Flow Depth and Velocity

Modified Depth and Velocity on Section 11A-48 to 63

Case Study	Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial		53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1		53.54	0.00	392.48		0.2	0.15	72	0	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-2		53.54	7.14	392.48	56.73	0.2	0.15	72	0.5	15	370.04	320.65	
11A-Case-3		53.54	3.57	392.48	56.73	0.2	0.15	72	1	15	156.39	112.48	
11A-Case-4		53.54	1.78	392.48	56.73	0.2	0.15	72	2	15	74.05	35.56	
11A-Case-5		53.54	1.19	392.48	56.73	0.2	0.15	72	3	15	55.67	20.16	
11A-Case-6		53.54	0.89	392.48		0.2	0.15	72	4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-7		53.54	0.71	392.48		0.2	0.15	72	5	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-8		53.54	0.59	392.48		0.2	0.15	72	6	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-9		53.54	0.51	392.48		0.2	0.15	72	7	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-10		53.54	0.45	392.48		0.2	0.15	72	8	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-11		53.54	0.40	392.48		0.2	0.15	72	9	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-12		53.54	0.36	392.48		0.2	0.15	72	10	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-13		53.54	0.24	392.48		0.2	0.15	72	15	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-14		53.54	0.18	392.48		0.2	0.15	72	20	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-15		53.54	0.14	392.48		0.2	0.15	72	25	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-16		53.54	0.12	392.48		0.2	0.15	72	30	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-17		53.54	0.09	392.48		0.2	0.15	72	40	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-18		53.54	0.07	392.48		0.2	0.15	72	50	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-19		53.54	0.05	392.48		0.2	0.15	72	75	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-20		53.54	0.04	392.48		0.2	0.15	72	100	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified Depth and Velocity on Section 11B-42.5 to 45.5

Case Study	Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial		34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1		34.60	0.00	256.00		0.18	0.15	72	0	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-2		34.60	23.07	256.00	23.91	0.18	0.15	72	0.5	3	236.79	208.67	
11B-Case-3		34.60	11.53	256.00	23.91	0.18	0.15	72	1	3	68.43	43.81	
11B-Case-4		34.60	5.77	256.00	23.91	0.18	0.15	72	2	3	44.02	21.71	
11B-Case-5		34.60	3.84	256.00	23.91	0.18	0.15	72	3	3	36.44	15.28	
11B-Case-6		34.60	2.88	256.00	23.91	0.18	0.15	72	4	3	32.18	11.92	
11B-Case-7		34.60	2.31	256.00	23.91	0.18	0.15	72	5	3	29.27	9.76	
11B-Case-8		34.60	1.92	256.00	23.91	0.18	0.15	72	6	3	27.18	8.32	
11B-Case-9		34.60	1.65	256.00	23.91	0.18	0.15	72	7	3	25.74	7.39	
11B-Case-10		34.60	1.44	256.00		0.18	0.15	72	8	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11B-Case-11		34.60	1.28	256.00		0.18	0.15	72	9	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11B-Case-12		34.60	1.15	256.00		0.18	0.15	72	10	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-13		34.60	0.77	256.00		0.18	0.15	72	15	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-14		34.60	0.58	256.00		0.18	0.15	72	20	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-15		34.60	0.46	256.00		0.18	0.15	72	25	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-16		34.60	0.38	256.00		0.18	0.15	72	30	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-17		34.60	0.29	256.00		0.18	0.15	72	40	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-18		34.60	0.23	256.00		0.18	0.15	72	50	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-19		34.60	0.15	256.00		0.18	0.15	72	75	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-20		34.60	0.12	256.00		0.18	0.15	72	100	3			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified Depth and Velocity on Section 11C -48 to 63

Case Study	Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial		60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1		60.69	0.00	255.38		0.22	0.16	72	0	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-2		60.69	8.09	255.38	41.85	0.22	0.16	72	0.5	15	204.93	163.26	
11c-Case-3		60.69	4.05	255.38	41.85	0.22	0.16	72	1	15	100.99	62.29	
11c-Case-4		60.69	2.02	255.38	41.85	0.22	0.16	72	2	15	57.54	24.09	
11c-Case-5		60.69	1.35	255.38	41.85	0.22	0.16	72	3	15	44.34	14.15	
11c-Case-6		60.69	1.01	255.38		0.22	0.16	72	4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-7		60.69	0.81	255.38		0.22	0.16	72	5	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-8		60.69	0.67	255.38		0.22	0.16	72	6	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-9		60.69	0.58	255.38		0.22	0.16	72	7	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-10		60.69	0.51	255.38		0.22	0.16	72	8	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-11		60.69	0.45	255.38		0.22	0.16	72	9	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-12		60.69	0.40	255.38		0.22	0.16	72	10	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-13		60.69	0.27	255.38		0.22	0.16	72	15	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-14		60.69	0.20	255.38		0.22	0.16	72	20	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-15		60.69	0.16	255.38		0.22	0.16	72	25	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-16		60.69	0.13	255.38		0.22	0.16	72	30	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-17		60.69	0.10	255.38		0.22	0.16	72	40	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-18		60.69	0.08	255.38		0.22	0.16	72	50	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-19		60.69	0.05	255.38		0.22	0.16	72	75	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-20		60.69	0.04	255.38		0.22	0.16	72	100	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Table J.11 – Detailed Data for Modification of Flow Depth and Sampling Distance

Modified Depth and Vertical Distance on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	53.54	1.48	392.48		0.2	0.15	72	0	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-2	53.54	1.48	392.48		0.2	0.15	72	0.5	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-3	53.54	1.48	392.48	56.73	0.2	0.15	72	1	15	80.79	40.48	
11A-Case-4	53.54	1.48	392.48	56.73	0.2	0.15	72	2	15	67.76	29.70	
11A-Case-5	53.54	1.48	392.48	56.73	0.2	0.15	72	3	15	63.54	26.41	
11A-Case-6	53.54	1.48	392.48	56.73	0.2	0.15	72	4	15	61.30	24.69	
11A-Case-7	53.54	1.48	392.48	56.73	0.2	0.15	72	5	15	59.94	23.61	
11A-Case-8	53.54	1.48	392.48	56.73	0.2	0.15	72	6	15	59.02	22.86	
11A-Case-9	53.54	1.48	392.48	56.73	0.2	0.15	72	7	15	58.19	22.25	
11A-Case-10	53.54	1.48	392.48	56.73	0.2	0.15	72	8	15	57.69	21.82	
11A-Case-11	53.54	1.48	392.48	56.73	0.2	0.15	72	9	15	57.28	21.47	
11A-Case-12	53.54	1.48	392.48	56.73	0.2	0.15	72	10	15	56.95	21.18	
11A-Case-13	53.54	1.48	392.48	56.73	0.2	0.15	72	15	15	55.82	20.21	
11A-Case-14	53.54	1.48	392.48	56.73	0.2	0.15	72	20	15	55.13	19.63	
11A-Case-15	53.54	1.48	392.48	56.73	0.2	0.15	72	25	15	54.65	19.24	
11A-Case-16	53.54	1.48	392.48	56.73	0.2	0.15	72	30	15	54.29	18.94	
11A-Case-17	53.54	1.48	392.48	56.73	0.2	0.15	72	40	15	53.78	18.54	
11A-Case-18	53.54	1.48	392.48		0.2	0.15	72	50	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-19	53.54	1.48	392.48		0.2	0.15	72	75	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-20	53.54	1.48	392.48		0.2	0.15	72	100	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified Depth and Vertical Distance on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	34.60	2.16	256.00		0.18	0.15	72	0	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-2	34.60	2.16	256.00		0.18	0.15	72	0.5	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-3	34.60	2.16	256.00		0.18	0.15	72	1	3			FAILED TO CONVERGE TO Z DURING MEP
11B-Case-4	34.60	2.16	256.00	23.91	0.18	0.15	72	2	3	32.49	11.49	
11B-Case-5	34.60	2.16	256.00	23.91	0.18	0.15	72	3	3	30.50	10.34	
11B-Case-6	34.60	2.16	256.00	23.91	0.18	0.15	72	4	3	29.41	9.72	
11B-Case-7	34.60	2.16	256.00	23.91	0.18	0.15	72	5	3	28.66	9.31	
11B-Case-8	34.60	2.16	256.00	23.91	0.18	0.15	72	6	3	28.20	9.03	
11B-Case-9	34.60	2.16	256.00	23.91	0.18	0.15	72	7	3	27.87	8.83	
11B-Case-10	34.60	2.16	256.00	23.91	0.18	0.15	72	8	3	27.61	8.66	
11B-Case-11	34.60	2.16	256.00	23.91	0.18	0.15	72	9	3	27.40	8.53	
11B-Case-12	34.60	2.16	256.00	23.91	0.18	0.15	72	10	3	27.22	8.41	
11B-Case-13	34.60	2.16	256.00	23.91	0.18	0.15	72	15	3	26.61	8.02	
11B-Case-14	34.60	2.16	256.00	23.91	0.18	0.15	72	20	3	26.23	7.78	
11B-Case-15	34.60	2.16	256.00	23.91	0.18	0.15	72	25	3	25.96	7.61	
11B-Case-16	34.60	2.16	256.00	23.91	0.18	0.15	72	30	3	25.75	7.49	
11B-Case-17	34.60	2.16	256.00	23.91	0.18	0.15	72	40	3	25.46	7.30	
11B-Case-18	34.60	2.16	256.00	23.91	0.18	0.15	72	50	3	25.26	7.17	
11B-Case-19	34.60	2.16	256.00	23.91	0.18	0.15	72	75	3	24.93	6.97	
11B-Case-20	34.60	2.16	256.00	23.91	0.18	0.15	72	100	3	24.74	6.84	

Modified Depth and Vertical Distance on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	60.69	1.57	255.38		0.22	0.16	72	0	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-2	60.69	1.57	255.38		0.22	0.16	72	0.5	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-3	60.69	1.57	255.38	41.85	0.22	0.16	72	1	15	61.67	25.82	
11c-Case-4	60.69	1.57	255.38	41.85	0.22	0.16	72	2	15	52.16	19.32	
11c-Case-5	60.69	1.57	255.38	41.85	0.22	0.16	72	3	15	49.05	17.32	
11c-Case-6	60.69	1.57	255.38	41.85	0.22	0.16	72	4	15	47.40	16.27	
11c-Case-7	60.69	1.57	255.38	41.85	0.22	0.16	72	5	15	46.40	15.61	
11c-Case-8	60.69	1.57	255.38	41.85	0.22	0.16	72	6	15	45.59	15.12	
11c-Case-9	60.69	1.57	255.38	41.85	0.22	0.16	72	7	15	45.11	14.78	
11c-Case-10	60.69	1.57	255.38	41.85	0.22	0.16	72	8	15	44.74	14.52	
11c-Case-11	60.69	1.57	255.38	41.85	0.22	0.16	72	9	15	44.44	14.30	
11c-Case-12	60.69	1.57	255.38	41.85	0.22	0.16	72	10	15	44.20	14.12	
11c-Case-13	60.69	1.57	255.38	41.85	0.22	0.16	72	15	15	43.37	13.53	
11c-Case-14	60.69	1.57	255.38	41.85	0.22	0.16	72	20	15	42.87	13.17	
11c-Case-15	60.69	1.57	255.38	41.85	0.22	0.16	72	25	15	42.51	12.92	
11c-Case-16	60.69	1.57	255.38	41.85	0.22	0.16	72	30	15	42.25	12.74	
11c-Case-17	60.69	1.57	255.38	41.85	0.22	0.16	72	40	15	41.87	12.49	
11c-Case-18	60.69	1.57	255.38		0.22	0.16	72	50	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-19	60.69	1.57	255.38		0.22	0.16	72	75	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING
11c-Case-20	60.69	1.57	255.38		0.22	0.16	72	100	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING

Table J.12 – Detailed Data for Mod of Depth, Discharge and Sampling Distance

Modified Depth , Vertical Distance and Flow on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	0.00	1.48	392.48		0.2	0.15	72	0	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-2	11.08	1.48	392.48		0.2	0.15	72	0.5	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-3	22.15	1.48	392.48	23.47	0.2	0.15	72	1	15	40.87	22.74	
11A-Case-4	44.30	1.48	392.48	46.95	0.2	0.15	72	2	15	57.49	25.72	
11A-Case-5	66.46	1.48	392.48	70.42	0.2	0.15	72	3	15	77.23	31.45	
11A-Case-6	88.61	1.48	392.48	93.90	0.2	0.15	72	4	15	97.49	37.63	
11A-Case-7	110.76	1.48	392.48	117.37	0.2	0.15	72	5	15	118.12	44.03	
11A-Case-8	132.91	1.48	392.48	140.85	0.2	0.15	72	6	15	138.97	50.56	
11A-Case-9	155.07	1.48	392.48	164.32	0.2	0.15	72	7	15	159.52	57.01	
11A-Case-10	177.22	1.48	392.48		0.2	0.15	72	8	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-11	199.37	1.48	392.48		0.2	0.15	72	9	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-12	221.52	1.48	392.48		0.2	0.15	72	10	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-13	332.29	1.48	392.48		0.2	0.15	72	15	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-14	443.05	1.48	392.48		0.2	0.15	72	20	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-15	553.81	1.48	392.48		0.2	0.15	72	25	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-16	664.57	1.48	392.48		0.2	0.15	72	30	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-17	886.10	1.48	392.48		0.2	0.15	72	40	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-18	1107.62	1.48	392.48		0.2	0.15	72	50	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-19	1661.43	1.48	392.48		0.2	0.15	72	75	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-20	2220.00	1.48	392.48		0.2	0.15	72	100	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified Depth , Vertical Distance and Flow on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	0.00	2.16	256.00		0.18	0.15	72	0	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-2	3.23	2.16	256.00		0.18	0.15	72	0.5	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-3	6.47	2.16	256.00	4.47	0.18	0.15	72	1	3	10.91	5.30	
11B-Case-4	12.93	2.16	256.00		0.18	0.15	72	2	3			FAILED TO CONVERGE TO Z DURING MEP
11B-Case-5	19.40	2.16	256.00	13.41	0.18	0.15	72	3	3	18.40	6.67	
11B-Case-6	25.87	2.16	256.00	17.88	0.18	0.15	72	4	3	22.68	7.74	
11B-Case-7	32.33	2.16	256.00	22.35	0.18	0.15	72	5	3	26.95	8.81	
11B-Case-8	38.80	2.16	256.00	26.82	0.18	0.15	72	6	3	31.33	9.92	
11B-Case-9	45.27	2.16	256.00	31.29	0.18	0.15	72	7	3	35.73	11.04	
11B-Case-10	51.73	2.16	256.00	35.76	0.18	0.15	72	8	3	40.14	12.17	
11B-Case-11	58.20	2.16	256.00	40.23	0.18	0.15	72	9	3	44.55	13.29	
11B-Case-12	64.67	2.16	256.00	44.70	0.18	0.15	72	10	3	48.97	14.42	
11B-Case-13	97.00	2.16	256.00	67.05	0.18	0.15	72	15	3	71.05	20.04	
11B-Case-14	129.34	2.16	256.00	89.40	0.18	0.15	72	20	3	93.08	25.63	
11B-Case-15	161.67	2.16	256.00		0.18	0.15	72	25	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-16	194.00	2.16	256.00		0.18	0.15	72	30	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-17	258.67	2.16	256.00		0.18	0.15	72	40	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-18	323.34	2.16	256.00		0.18	0.15	72	50	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-19	485.01	2.16	256.00		0.18	0.15	72	75	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-20	646.68	2.16	256.00		0.18	0.15	72	100	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...

Modified Depth , Vertical Distance and Flow on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	0.00	1.57	255.38		0.22	0.16	72	0	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-2	11.78	1.57	255.38		0.22	0.16	72	0.5	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-3	23.55	1.57	255.38		0.22	0.16	72	1	15			FAILED TO CONVERGE TO Z DURING MEP
11c-Case-4	47.11	1.57	255.38	32.48	0.22	0.16	72	2	15	41.80	15.92	
11c-Case-5	70.66	1.57	255.38	48.72	0.22	0.16	72	3	15	56.30	19.60	
11c-Case-6	94.21	1.57	255.38	64.96	0.22	0.16	72	4	15	71.15	23.55	
11c-Case-7	117.76	1.57	255.38	81.20	0.22	0.16	72	5	15	86.24	27.62	
11c-Case-8	141.32	1.57	255.38	97.44	0.22	0.16	72	6	15	101.19	31.67	
11c-Case-9	164.87	1.57	255.38	113.68	0.22	0.16	72	7	15	116.51	35.84	
11c-Case-10	188.42	1.57	255.38		0.22	0.16	72	8	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-11	211.98	1.57	255.38		0.22	0.16	72	9	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-12	235.53	1.57	255.38		0.22	0.16	72	10	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-13	353.29	1.57	255.38		0.22	0.16	72	15	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-14	471.06	1.57	255.38		0.22	0.16	72	20	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-15	588.82	1.57	255.38		0.22	0.16	72	25	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-16	706.59	1.57	255.38		0.22	0.16	72	30	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-17	942.12	1.57	255.38		0.22	0.16	72	40	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-18	1177.65	1.57	255.38		0.22	0.16	72	50	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11c-Case-19	1766.47	1.57	255.38		0.22	0.16	72	75	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-20	2355.00	1.57	255.38		0.22	0.16	72	100	15			NOT ENOUGH OVERLAPPING BINS FOR MEP

Table J.13 – Detailed Data for Modification of Discharge and Velocity

Modified Flow and Velocity on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.535	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	0	0.00	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-2	1	0.02	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-3	2	0.04	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-4	3	0.06	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-5	4	0.09	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-6	5	0.11	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-7	10	0.22	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-8	20	0.43	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-9	40	0.86	392.48		0.2	0.15	72	3.1	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-10	60	1.29	392.48	63.58	0.2	0.15	72	3.1	15	64.61	24.33	
11A-Case-11	80	1.72	392.48	84.78	0.2	0.15	72	3.1	15	101.07	44.52	
11A-Case-12	100	2.15	392.48	105.97	0.2	0.15	72	3.1	15	146.35	72.66	
11A-Case-13	150	3.23	392.48	158.95	0.2	0.15	72	3.1	15	277.84	160.61	
11A-Case-14	200	4.30	392.48	211.94	0.2	0.15	72	3.1	15	421.65	260.63	
11A-Case-15	250	5.38	392.48	264.92	0.2	0.15	72	3.1	15	577.84	372.37	
11A-Case-16	300	6.45	392.48	317.91	0.2	0.15	72	3.1	15	746.11	495.55	
11A-Case-17	350	7.53	392.48	370.89	0.2	0.15	72	3.1	15	926.01	629.85	
11A-Case-18	400	8.60	392.48	423.88	0.2	0.15	72	3.1	15	1117.49	775.10	
11A-Case-19	500	10.75	392.48	529.85	0.2	0.15	72	3.1	15	1534.02	1097.80	
11A-Case-20	1000	21.51	392.48	1059.70	0.2	0.15	72	3.1	15	4238.85	3310.56	

Modified Flow and Velocity onSection 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	0.00	0.00	256.00		0.18	0.15	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-2	1.00	0.06	256.00		0.18	0.15	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-3	2.00	0.12	256.00		0.18	0.15	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-4	3.00	0.19	256.00		0.18	0.15	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-5	4.00	0.25	256.00		0.18	0.15	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-6	5.00	0.31	256.00		0.18	0.15	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-7	10.00	0.62	256.00		0.18	0.15	72	5.4	3			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-8	20.00	1.23	256.00		0.18	0.15	72	5.4	3			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11B-Case-9	40.00	2.47	256.00	27.65	0.18	0.15	72	5.4	3	34.41	11.66	
11B-Case-10	60.00	3.70	256.00	41.47	0.18	0.15	72	5.4	3	57.89	22.03	
11B-Case-11	80.00	4.94	256.00	55.30	0.18	0.15	72	5.4	3	82.29	33.20	
11B-Case-12	100.00	6.17	256.00	69.12	0.18	0.15	72	5.4	3	107.85	45.35	
11B-Case-13	150.00	9.26	256.00	103.68	0.18	0.15	72	5.4	3	176.30	79.45	
11B-Case-14	200.00	12.35	256.00	138.24	0.18	0.15	72	5.4	3	250.85	118.55	
11B-Case-15	250.00	15.43	256.00	172.80	0.18	0.15	72	5.4	3	331.07	162.43	
11B-Case-16	300.00	18.52	256.00	207.36	0.18	0.15	72	5.4	3	416.66	210.88	
11B-Case-17	350.00	21.60	256.00	241.92	0.18	0.15	72	5.4	3	507.29	263.20	
11B-Case-18	400.00	24.69	256.00	276.48	0.18	0.15	72	5.4	3	606.41	324.08	
11B-Case-19	500.00	30.86	256.00	345.60	0.18	0.15	72	5.4	3	813.61	452.52	
11B-Case-20	1000.00	61.73	256.00	691.20	0.18	0.15	72	5.4	3	2072.61	1285.34	

Modified Flow and Velocity on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.688	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	0	0.00	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-2	1	0.02	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-3	2	0.04	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-4	3	0.06	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-5	4	0.08	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-6	5	0.10	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-7	10	0.20	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-8	20	0.39	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-9	40	0.78	255.38		0.22	0.16	72	3.4	15			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-10	60	1.18	255.38		0.22	0.16	72	3.4	15			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING…
11c-Case-11	80	1.57	255.38	55.16	0.22	0.16	72	3.4	15	62.11	21.12	
11c-Case-12	100	1.96	255.38	68.95	0.22	0.16	72	3.4	15	87.00	33.14	
11c-Case-13	150	2.94	255.38	103.43	0.22	0.16	72	3.4	15	159.48	72.22	
11c-Case-14	200	3.92	255.38	137.91	0.22	0.16	72	3.4	15	237.13	116.28	
11c-Case-15	250	4.90	255.38	172.38	0.22	0.16	72	3.4	15	318.62	163.92	
11c-Case-16	300	5.88	255.38	206.86	0.22	0.16	72	3.4	15	404.44	215.09	
11c-Case-17	350	6.86	255.38	241.34	0.22	0.16	72	3.4	15	494.37	270.52	
11c-Case-18	400	7.84	255.38	275.82	0.22	0.16	72	3.4	15	588.72	329.29	
11c-Case-19	500	9.80	255.38	344.77	0.22	0.16	72	3.4	15	789.64	457.59	
11c-Case-20	1000	19.61	255.38	689.54	0.22	0.16	72	3.4	15	2025.71	1309.90	

Table J.14 – Detailed Data for Modification of Width and Discharge

Modified Width and Flow on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	0.00	1.48	392.48		0.2	0.15	72	3.1	0			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-2	11.45	1.48	392.48	12.13	0.2	0.15	72	3.1	2.5	13.21	5.34	
11A-Case-3	22.89	1.48	392.48	24.26	0.2	0.15	72	3.1	5	26.41	10.69	
11A-Case-4	45.78	1.48	392.48	48.51	0.2	0.15	72	3.1	10	52.83	21.37	
11A-Case-5	91.56	1.48	392.48	97.03	0.2	0.15	72	3.1	20	105.65	42.74	
11A-Case-6	114.45	1.48	392.48	121.29	0.2	0.15	72	3.1	25	132.07	53.43	
11A-Case-7	137.34	1.48	392.48	145.54	0.2	0.15	72	3.1	30	158.48	64.12	
11A-Case-8	160.24	1.48	392.48	169.80	0.2	0.15	72	3.1	35	184.89	74.80	
11A-Case-9	183.13	1.48	392.48	194.06	0.2	0.15	72	3.1	40	211.31	85.49	
11A-Case-10	206.02	1.48	392.48	218.32	0.2	0.15	72	3.1	45	237.72	96.17	
11A-Case-11	228.91	1.48	392.48	242.57	0.2	0.15	72	3.1	50	264.13	106.86	
11A-Case-12	274.69	1.48	392.48	291.09	0.2	0.15	72	3.1	60	316.96	128.23	
11A-Case-13	320.47	1.48	392.48	339.60	0.2	0.15	72	3.1	70	369.79	149.60	
11A-Case-14	366.25	1.48	392.48	388.12	0.2	0.15	72	3.1	80	422.61	170.98	
11A-Case-15	412.03	1.48	392.48	436.63	0.2	0.15	72	3.1	90	475.44	192.35	
11A-Case-16	457.82	1.48	392.48	485.15	0.2	0.15	72	3.1	100	528.27	213.72	
11A-Case-17	1144.54	1.48	392.48	1212.87	0.2	0.15	72	3.1	250	1320.67	534.30	
11A-Case-18	2289.08	1.48	392.48	2425.73	0.2	0.15	72	3.1	500	2641.34	1068.60	
11A-Case-19	4578.17	1.48	392.48	4851.46	0.2	0.15	72	3.1	1000	5282.67	2137.20	
11A-Case-20	9176.00	1.48	392.48	9702.93	0.2	0.15	72	3.1	2000	10565.35	4274.40	

Modified Width and Flow on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.46	9.19	
11B-Case-1	0.00	2.16	256.00		0.18	0.15	72	5.4	0			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-2	29.10	2.16	256.00	20.11	0.18	0.15	72	5.4	2.5	23.92	7.71	
11B-Case-3	58.20	2.16	256.00	40.23	0.18	0.15	72	5.4	5	47.83	15.43	
11B-Case-4	116.40	2.16	256.00	80.46	0.18	0.15	72	5.4	10	95.67	30.85	
11B-Case-5	232.81	2.16	256.00	160.92	0.18	0.15	72	5.4	20	191.33	61.70	
11B-Case-6	291.01	2.16	256.00	201.14	0.18	0.15	72	5.4	25	239.17	77.13	
11B-Case-7	349.21	2.16	256.00	241.37	0.18	0.15	72	5.4	30	287.00	92.55	
11B-Case-8	407.41	2.16	256.00	281.60	0.18	0.15	72	5.4	35	334.83	107.98	
11B-Case-9	465.61	2.16	256.00	321.83	0.18	0.15	72	5.4	40	382.67	123.40	
11B-Case-10	523.81	2.16	256.00	362.06	0.18	0.15	72	5.4	45	430.50	138.83	
11B-Case-11	582.01	2.16	256.00	402.29	0.18	0.15	72	5.4	50	478.33	154.25	
11B-Case-12	698.42	2.16	256.00	482.75	0.18	0.15	72	5.4	60	574.00	185.10	
11B-Case-13	814.82	2.16	256.00	563.20	0.18	0.15	72	5.4	70	669.67	215.95	
11B-Case-14	931.22	2.16	256.00	643.66	0.18	0.15	72	5.4	80	765.33	246.80	
11B-Case-15	1047.63	2.16	256.00	724.12	0.18	0.15	72	5.4	90	861.00	277.65	
11B-Case-16	1164.03	2.16	256.00	804.58	0.18	0.15	72	5.4	100	956.67	308.50	
11B-Case-17	2910.07	2.16	256.00	2011.44	0.18	0.15	72	5.4	250	2391.67	771.26	
11B-Case-18	5820.14	2.16	256.00	4022.88	0.18	0.15	72	5.4	500	4783.33	1542.52	
11B-Case-19	11640.28	2.16	256.00	8045.76	0.18	0.15	72	5.4	1000	9566.66	3085.04	
11B-Case-20	23280.56	2.16	256.00	16091.52	0.18	0.15	72	5.4	2000	19133.33	6170.08	

Modified Width and Flow on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	0.00	1.57	255.38		0.22	0.16	72	3.4	0			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-2	13.35	1.57	255.38	9.20	0.22	0.16	72	3.4	2.5	10.37	3.53	
11c-Case-3	26.69	1.57	255.38	18.41	0.22	0.16	72	3.4	5	20.74	7.05	
11c-Case-4	53.39	1.57	255.38	36.81	0.22	0.16	72	3.4	10	41.47	14.11	
11c-Case-5	106.77	1.57	255.38	73.62	0.22	0.16	72	3.4	20	82.94	28.21	
11c-Case-6	133.47	1.57	255.38	92.03	0.22	0.16	72	3.4	25	103.68	35.27	
11c-Case-7	160.16	1.57	255.38	110.44	0.22	0.16	72	3.4	30	124.41	42.32	
11c-Case-8	186.85	1.57	255.38	128.84	0.22	0.16	72	3.4	35	145.15	49.37	
11c-Case-9	213.55	1.57	255.38	147.25	0.22	0.16	72	3.4	40	165.88	56.43	
11c-Case-10	240.24	1.57	255.38	165.65	0.22	0.16	72	3.4	45	186.62	63.48	
11c-Case-11	266.93	1.57	255.38	184.06	0.22	0.16	72	3.4	50	207.36	70.53	
11c-Case-12	320.32	1.57	255.38	220.87	0.22	0.16	72	3.4	60	248.83	84.64	
11c-Case-13	373.71	1.57	255.38	257.68	0.22	0.16	72	3.4	70	290.30	98.75	
11c-Case-14	427.09	1.57	255.38	294.50	0.22	0.16	72	3.4	80	331.77	112.86	
11c-Case-15	480.48	1.57	255.38	331.31	0.22	0.16	72	3.4	90	373.24	126.96	
11c-Case-16	533.87	1.57	255.38	368.12	0.22	0.16	72	3.4	100	414.71	141.07	
11c-Case-17	1334.66	1.57	255.38	920.30	0.22	0.16	72	3.4	250	1036.78	352.67	
11c-Case-18	2669.33	1.57	255.38	1840.61	0.22	0.16	72	3.4	500	2073.55	705.35	
11c-Case-19	5338.66	1.57	255.38	3681.21	0.22	0.16	72	3.4	1000	4147.11	1410.70	
11c-Case-20	10676.00	1.57	255.38	7362.42	0.22	0.16	72	3.4	2000	8294.21	2821.39	

Table J.15 – Detailed Data for Modification of Width and Velocity

Modified Width and Velocity on Section 11A-48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11A-Initial	53.54	1.48	392.48	56.73	0.2	0.15	72	3.1	15	63.26	26.19	
11A-Case-1	53.54	0.00	392.48		0.2	0.15	72	3.1	0			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-2	53.54	6.91	392.48	56.73	0.2	0.15	72	3.1	2.5	136.83	91.86	
11A-Case-3	53.54	3.45	392.48	56.73	0.2	0.15	72	3.1	5	102.55	60.38	
11A-Case-4	53.54	1.73	392.48	56.73	0.2	0.15	72	3.1	10	67.82	29.95	
11A-Case-5	53.54	0.86	392.48		0.2	0.15	72	3.1	20			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-6	53.54	0.69	392.48		0.2	0.15	72	3.1	25			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-7	53.54	0.58	392.48		0.2	0.15	72	3.1	30			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-8	53.54	0.49	392.48		0.2	0.15	72	3.1	35			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-9	53.54	0.43	392.48		0.2	0.15	72	3.1	40			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-10	53.54	0.38	392.48		0.2	0.15	72	3.1	45			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-11	53.54	0.35	392.48		0.2	0.15	72	3.1	50			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-12	53.54	0.29	392.48		0.2	0.15	72	3.1	60			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-13	53.54	0.25	392.48		0.2	0.15	72	3.1	70			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-14	53.54	0.22	392.48		0.2	0.15	72	3.1	80			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-15	53.54	0.19	392.48		0.2	0.15	72	3.1	90			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-16	53.54	0.17	392.48		0.2	0.15	72	3.1	100			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-17	53.54	0.07	392.48		0.2	0.15	72	3.1	250			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-18	53.54	0.03	392.48		0.2	0.15	72	3.1	500			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-19	53.54	0.02	392.48		0.2	0.15	72	3.1	1000			NOT ENOUGH OVERLAPPING BINS FOR MEP
11A-Case-20	53.54	0.01	392.48		0.2	0.15	72	3.1	2000			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified Width and Velocity on Section 11B-42.5 to 45.5

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11B-Initial	34.60	2.16	256.00	23.91	0.18	0.15	72	5.4	3	28.45729843	9.185573729	
11B-Case-1	34.60	0.00	256.00		0.18	0.15	72	5.4	0			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-2	34.60	2.56	256.00	23.91	0.18	0.15	72	5.4	2.5	30.12598845	10.34169814	
11B-Case-3	34.60	1.28	256.00		0.18	0.15	72	5.4	5			FITTED Z-VALUES GENERATED NEGATIVE EXPONENT NOT CONTINUING...
11B-Case-4	34.60	0.64	256.00		0.18	0.15	72	5.4	10			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-5	34.60	0.32	256.00		0.18	0.15	72	5.4	20			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-6	34.60	0.26	256.00		0.18	0.15	72	5.4	25			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-7	34.60	0.21	256.00		0.18	0.15	72	5.4	30			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-8	34.60	0.18	256.00		0.18	0.15	72	5.4	35			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-9	34.60	0.16	256.00		0.18	0.15	72	5.4	40			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-10	34.60	0.14	256.00		0.18	0.15	72	5.4	45			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-11	34.60	0.13	256.00		0.18	0.15	72	5.4	50			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-12	34.60	0.11	256.00		0.18	0.15	72	5.4	60			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-13	34.60	0.09	256.00		0.18	0.15	72	5.4	70			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-14	34.60	0.08	256.00		0.18	0.15	72	5.4	80			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-15	34.60	0.07	256.00		0.18	0.15	72	5.4	90			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-16	34.60	0.06	256.00		0.18	0.15	72	5.4	100			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-17	34.60	0.03	256.00		0.18	0.15	72	5.4	250			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-18	34.60	0.01	256.00		0.18	0.15	72	5.4	500			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-19	34.60	0.01	256.00		0.18	0.15	72	5.4	1000			NOT ENOUGH OVERLAPPING BINS FOR MEP
11B-Case-20	34.60	0.00	256.00		0.18	0.15	72	5.4	2000			NOT ENOUGH OVERLAPPING BINS FOR MEP

Modified Width and Velocity on Section 11C -48 to 63

Case Study Location	Discharge (cfs)	Velocity (ft/sec)	Concentration (ppm)	Suspended Sediment Sample (ton/day)	d_{65} (mm)	d_{35} (mm)	Temp (F)	h (ft)	W (ft)	Total Load (tons/day)	Total Sand Load (>0.625mm)(tons/day)	Notes on Error
11c-Initial	60.69	1.57	255.38	41.85	0.22	0.16	72	3.4	15	48.28	16.83	
11c-Case-1	60.69	0.00	255.38		0.22	0.16	72	3.4	0			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-2	60.69	7.14	255.38	41.85	0.22	0.16	72	3.4	2.5	86.76	47.79	
11c-Case-3	60.69	3.57	255.38	41.85	0.22	0.16	72	3.4	5	69.62	33.36	
11c-Case-4	60.69	1.78	255.38	41.85	0.22	0.16	72	3.4	10	50.25	18.24	
11c-Case-5	60.69	0.89	255.38		0.22	0.16	72	3.4	20			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-6	60.69	0.71	255.38		0.22	0.16	72	3.4	25			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-7	60.69	0.59	255.38		0.22	0.16	72	3.4	30			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-8	60.69	0.51	255.38		0.22	0.16	72	3.4	35			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-9	60.69	0.45	255.38		0.22	0.16	72	3.4	40			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-10	60.69	0.40	255.38		0.22	0.16	72	3.4	45			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-11	60.69	0.36	255.38		0.22	0.16	72	3.4	50			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-12	60.69	0.30	255.38		0.22	0.16	72	3.4	60			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-13	60.69	0.25	255.38		0.22	0.16	72	3.4	70			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-14	60.69	0.22	255.38		0.22	0.16	72	3.4	80			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-15	60.69	0.20	255.38		0.22	0.16	72	3.4	90			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-16	60.69	0.18	255.38		0.22	0.16	72	3.4	100			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-17	60.69	0.07	255.38		0.22	0.16	72	3.4	250			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-18	60.69	0.04	255.38		0.22	0.16	72	3.4	500			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-19	60.69	0.02	255.38		0.22	0.16	72	3.4	1000			NOT ENOUGH OVERLAPPING BINS FOR MEP
11c-Case-20	60.69	0.01	255.38		0.22	0.16	72	3.4	2000			NOT ENOUGH OVERLAPPING BINS FOR MEP