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Resource and cost loading of an urban highway project

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Resource and cost loading of an urban highway project

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ABSTRACT

The researcher worked in coordination with the Iowa Department of Transportation (Iowa DOT) on the resource and cost loading of the Interstate 235 (I-235) project in the city of Des Moines and West Des Moines, Iowa. The construction of the project began in the year 2000 and is projected to complete in the year 2006. The projected cost of reconstruction is at $426 million. The cost includes the construction of more than 80 bridges, 20 interchanges, installation of utilities, and the widening of the entire I-235 main roadway. A considerable number of resources were reviewed and methods to improve the process of resourcing were analyzed. This thesis focuses on the methods of quantity takeoffs as well as other alternatives of resource analysis for materials, funding and people. The researcher explains how, why and what resources affects construction. Finally, the thesis contains researcher's results, recommendations and implementation steps for resourcing a project of this size.

CHAPTER 1: INTRODUCTION TO I-235 AND RESOURCES

1.1 Introduction

The Interstate 235 (I-235) corridor anchors a major urban traffic network of interchanges, roads and bridges. The Iowa Department of Transportation (Iowa DOT) has determined that a 14-mile stretch of this corridor is in immediate need for reconstruction to improve its capacity, safety to the traveling public and support economic development. A project of this complexity demands critical attention to resource allocation and management to meet goals of on time construction, within budget and minimal impact to the traveling public. Therefore, the ability to sufficiently resource a project of this magnitude is of the utmost importance. This paper will address the process and requirements to ensure such resource availability.

The construction of an urban highway begins with a conceptual design of a bridge or the roadway that will be constructed. Once the conceptual design is completed, evaluated, and finalized for construction, a quantity table of materials is placed on the design plans. Finally, the cost of the construction is determined. The project plans then are passed on to the contracts office where the project is released for public bidding. The typical process mentioned above is satisfactory for estimating material resources when construction consists of one or two small projects. However, the evaluation of the reconstruction of I-235 in the cities of Des Moines and West Des Moines, Iowa is not your typical Iowa DOT project, but one where numerous projects will be constructed at once and within a 4-year construction timeframe.

During the design and contracts approval process, the need for resource loading became apparent on this 14-mile corridor of I-235 urban highway reconstruction. The reconstruction project scope involves widening of the existing roadway from two lanes to three lanes and the entire reconstruction and replacement of all bridges within the corridor as discussed here. The widening process will also consist of strengthening of shoulders to redirect traffic during the construction of the median and inner lanes. The bridges and interchanges will be constructed in the first two years of the project and the widening will occur during the last two years prior to the completion of the project.

A total of more than 80 bridges and 20 interchanges will be constructed along the 14 mile I-235 corridor. The bridges along the west end and north end of the corridor will be Pretensioned-Prestressed Concrete Beam Bridges (PPCB) and along the downtown (center) of the corridor will be Steel Girder Bridges. All bridges will be constructed of high-performance Portland Cement Concrete (PCC) decks. The mainline will be constructed using PCC in the downtown area and a SUPERPAVE mix of Asphalt Cement Concrete (ACC) along the outer areas of the corridor. This will require an extensive supply of resources within the 4-year span of construction. Therefore, estimation of resources must be undertaken to determine the amount of resources required for construction. Information concerning the availability of resources, as planned/designed, will minimize the possibility that a project might be delayed because of unavailability of a particular resource during any of the years of construction.

The need to know quantities of materials prior to the construction along I-235 is critical. The owner, in this instance the Iowa DOT, requires that all projects on I-235 must be completed by the year 2006. An unavailability of any resource such as aggregate or steel or labor at an early stage of construction could cause a delay to an activity or operation on the critical path causing a delay to all subsequent projects.

Possible shortages of materials such as steel and aggregate were of concern to the Iowa DOT. Such concerns were raised during my research/interviews with representatives of the Iowa DOT that the state of Iowa, quite possibly might not have the resources to meet the demands for the I-235 construction, unless suppliers have sufficient lead-time for preparation. The question was then asked as to what materials and which years of the construction project were the most critical and what steps should to be taken to ensure that enough resources will be available. Iowa DOT has addressed the possibility of shortages by stockpiling aggregate. Assessment of criticality and the process of ensuring resource availability will be answered in chapters that follow.

As a shortage of items such as reinforcing steel or PCC on bridge deck or ACC on the main road can delay the completion of a project, resource loading must be applied to the schedule on I-235. Notwithstanding that the process of resource loading is considered, according to Callahan (p. 277), to be quite time consuming.

The main focus of Chapter 1 will be an overview of the I-235 project and a review of previously developed methods to evaluate resources as generally accepted by the industry, and reasons for considering resources for a project of this size. In Chapter 2, a method for systematically considering resources will be developed. Chapter 3 will demonstrate the method for a case study on I-235. Chapter 4 focuses on estimating requirements for personnel and gives a case study of demand for inspectors on I-235. Cost loading and the process of balancing $426 million cash flow will be the topic of Chapter 5. Chapter 6 will include research conclusions, recommendations, and critical steps to approaching the process of resourcing a project of this size and complexity.

1.2 Overview of I-235

The I-235 corridor begins at the northeast interchange of I-35/I-80/I-235 (locally known as the "East Mixmaster") and proceeds through the cities of Des Moines and West Des Moines. The corridor ends just west of the 50th Street interchange at the I-35/I-80/I-235 (also commonly known as the "West Mixmaster"), see Figure 1.1. The city limits of Des Moines begin just south of the East Mixmaster interchange and proceed along I-235 to just west of the 63rd Street Bridge.

The Iowa DOT divided the 14-mile I-235 corridor into 10 sections because of the detailed plans of reconstruction. This division of I-235 into 10 individual sections will be considered as one project in practice to increase efficiency in planning construction and scheduling of projects for reconstruction.

Section 1 is east of the West Mixmaster and section 10 is at the East Mixmaster. Sections 1 to 4 begin just west of the 50th Street Bridge in the City of West Des Moines and end just east of the 28th Street Bridge in Des Moines. Section 5 continues from that point through the downtown area to the east side of the Des Moines River Bridge. Section 6 starts at the east side of the Des Moines River Bridge and ends at the University Avenue area. Section 7 includes the entire University Avenue area up to just south of Guthrie Avenue. The remainder of the I-235 corridor from Guthrie Avenue to just south of East Mixmaster interchange comprises sections 8 through 10.

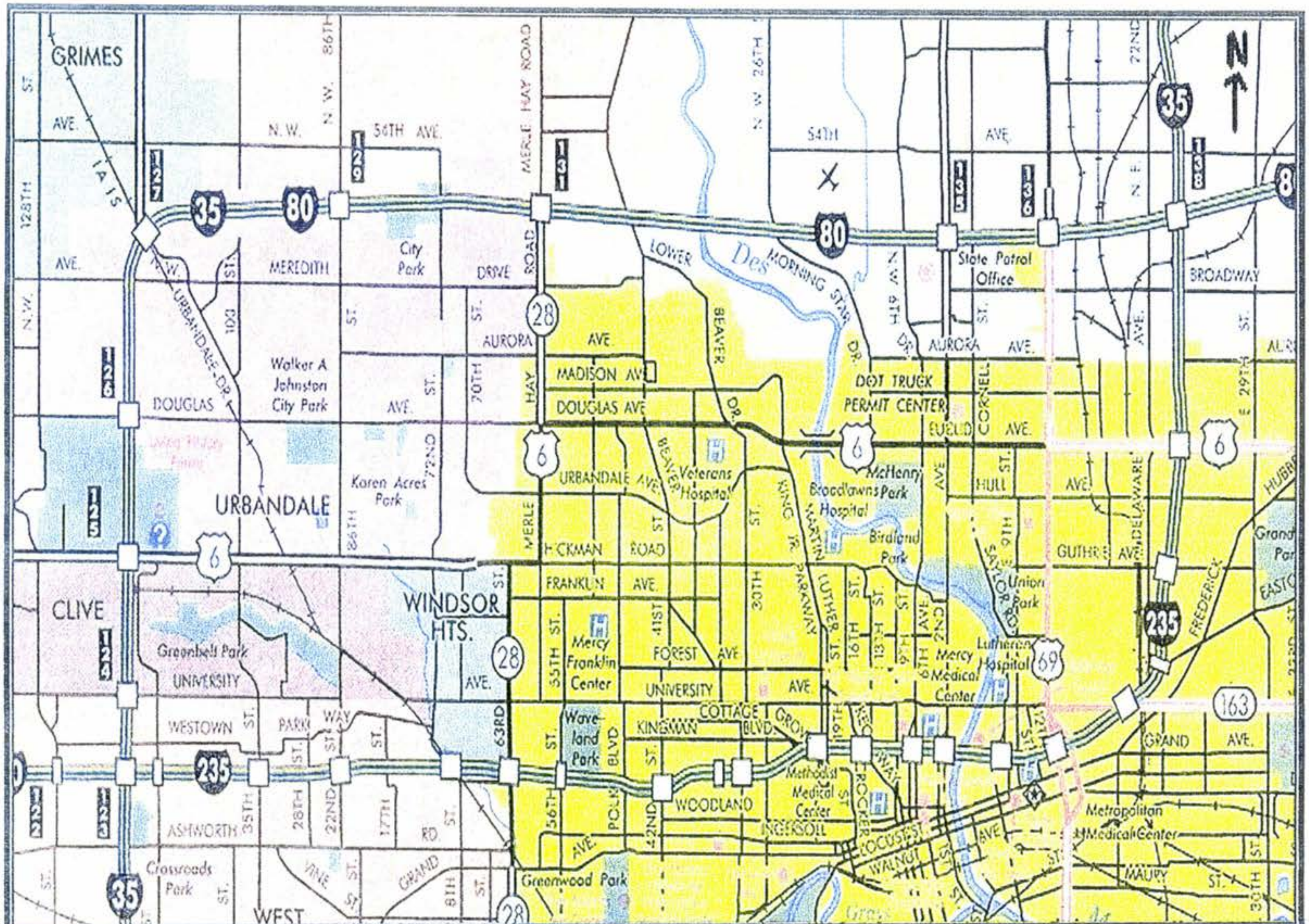


Figure 1.1 Map of the I-235 and the Des Moines Area (Iowa DOT: 2001 Transportation Map)

1.3 New Construction

The I-235 corridor will be open during the entire construction period except for the bridges that will be closed when under construction. The construction of the bridges will occur in the years 2002 to 2004. The construction period of 2005 and 2006 will focus mainly on the reconstruction and widening of the mainline pavements.

The closure of bridges will alternate, so that no two consecutive bridges or interchanges will be closed at the same time. A study conducted by the Iowa DOT during the pre-construction phase indicated that an interchange cannot meet the demands of traffic should two or more consecutive interchange closures occur. The assigned year of construction for each bridge was also dependent on the type of existing bridge present. The bridges currently in place must be replaced because of the mainline reconstruction. Mainline pavement will be replaced, widened and the entire roadway will be raised an additional eight inches from the existing grade. The raising of the pavement requires the replacement of all bridges along the corridor to provide adequate vertical clearance for vehicles traveling on I-235.

Four of the existing bridges along I-235 are concrete box beam bridges and the remaining are concrete or steel beam bridges. A typical design of a box beam bridge can be seen below in Figure 1.2. These bridges will be replaced with Steel Girder, see Figure. 1.3 or Pretensioned Prestressed Concrete Bridge (PPCB), see Figure 1.4. The replacement of the bridges will be combined with the reconstruction of bridge interchanges to better accommodate traffic and access to and from mainline I-235.

The mainline of I-235 will undergo complete reconstruction. The roadway will be widened to at least three lanes over the entire corridor with additional lanes in high traffic areas. The reason for such a major reconstruction is to accommodate traffic demand;

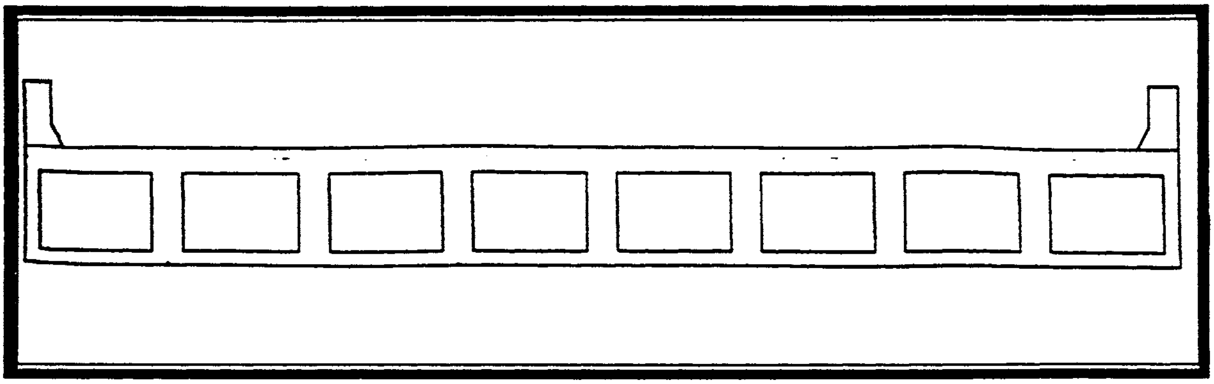


Figure 1.2. Typical Cross-Section of Box Beam Bridge

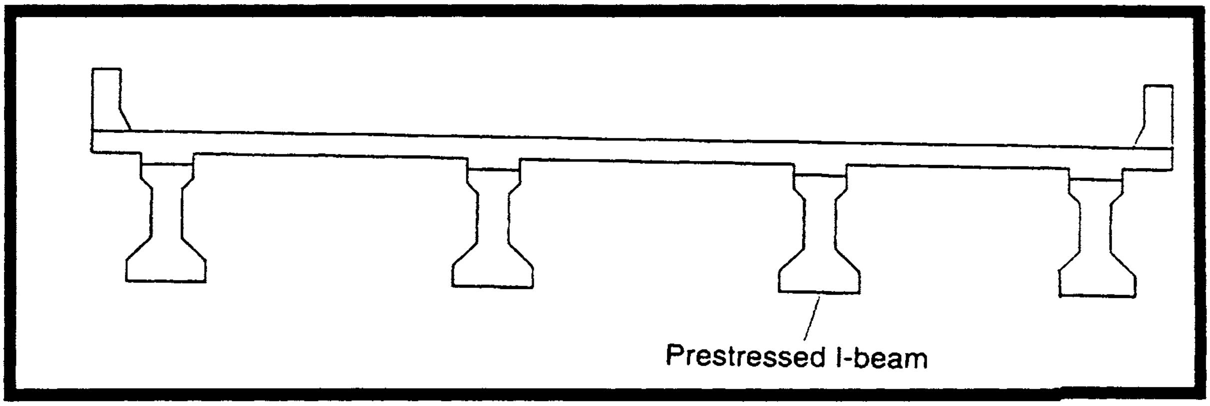


Figure 1.3. Typical of Pretensioned Prestressed Concrete Bridge (Brockenbrough p. 4.30)

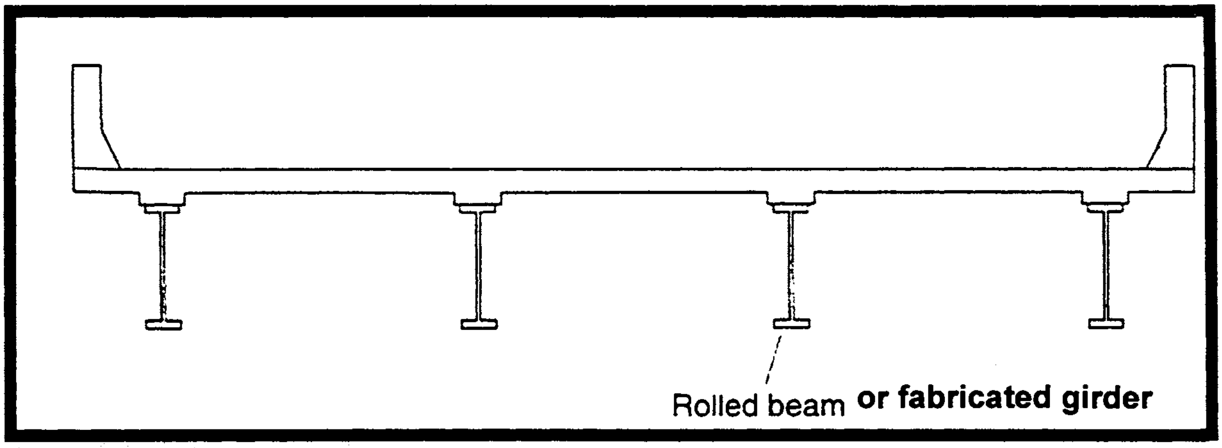


Figure 1.4. Typical of Steel Girder Bridge (Brockenbrough p. 4.31)

improve the road geometry; increase entrance and exit taper spacing; and to eliminate conflict points at the interchanges where lanes drop at exits and traffic enters from the left.

1.4 How Resources Influence the Schedule

Resources constrain the schedule. According to Willis (p. 323), a resource material constrained scheduling problem occurs because of the following;

1. Material is not available at the time needed
2. Resource delivery is delayed
3. Unknown project progress may limit the possibility to secure additional resources
4. Impossibility to assign resources to places needed

Willis also addresses labor resources and how to minimize the impacts such resource shortages have on continuous progress and completion of a project. Willis advises, that to minimize resource shortages, one must do the following:

1. Assign priorities for allocation of scarce resources – most critical tasks get resources first;
2. Assign performance of tasks on a non-continuous basis – continuous tasks must be carried out until completion;
3. Change level of resource commitment to tasks – increasing resource commitment will reduce task durations;
4. Giving priority to the most nearly critical task(s).

Prioritizing the most critical tasks and properly allocating the required resources, both material and labor will minimize delays of each individual project and shorten the completion time for the entire I-235 project.

1.5 How Estimating is Done

The Means Heavy Construction Handbook (1993 p. 26) states that most contractors use their own standardized computer worksheets to record quantity takeoffs. Unfortunately, not all projects are alike. Quantity takeoffs from plans are very time consuming. Also, projects are influenced by location and field constraints.

Quantity takeoffs, according to Ringwald (p. 41-44) are usually taken off the plans and determined on a station-to-station basis. Planners for I-235 are unable to perform detailed quantity takeoffs for the entire I-235 project as final designs are completed just in time prior to letting the project for construction. However, another alternative is to use information from previous projects with similar uniformity in size. A more in-depth process and review of the above stated methods will be discussed in Chapter 2.

1.6 Conclusion

The construction of I-235 will be intensive from 2002 to 2006. The plans for the new structures to be constructed are being completed shortly before individual projects are let. For example, in the year 2002 there are a total of five structures being constructed. The availability of resources to complete the projects is critical. A delay in the completion date of any of the year 2002 projects can affect the construction of future projects for the next 3 years. Even though projects are let individually, they share material and labor resources. Thus, the industry needs to know what resources are going to be critical. A resource method that combines previous approaches of resource estimating is being applied on the I-235 reconstruction. The review and analysis of such a conceptual method of estimating resources prior to completion of design plans is explained in more detail in Chapters 2 and 3.

CHAPTER 2: CONCEPTUAL RESOURCE ESTIMATE FOR BRIDGES

2.1 Introduction

In order to conduct analysis of a resource method, numerous data were collected from previous urban and rural (bridge and roadway) construction projects. The researcher visited three Iowa DOT facilities and gathered contracts of projects constructed in the last 4 years that were similar in the scope of construction to the I-235 projects. All of the projects reviewed by the researcher were constructed in the northeastern and central regions of the state of Iowa.

The researcher used the information from the contracts to calculate a factor that can be used to estimate material quantities on bridges. The factor is a quantity of various materials per area of bridge deck. Each material contract item had its own factor. The researcher then applied the calculated factor to the I-235 projects and compared quantities to determine the effectiveness of using such a method to estimate resources. A comparison was then conducted between the calculated quantities based on a factor (for a specific item) and the quantities stated in the plans (of I-235 projects) sent to the contractors for bid.

2.2 Gathering Data

The contracts were first categorized according to the type of structure constructed. Below is the list of the PPCB and Steel Bridges from which information was compiled to find the factor. There were a total of 3 Steel Bridges and 10 PPCB Bridges reviewed. Information was then used to calculate a factor for each of the 4 items of interest to the researcher. The items were structural concrete (bridge), reinforcing steel, reinforcing steel epoxy-coated, and structural steel. The Iowa DOT specified that steel resources are as important as aggregate resources for construction of bridges.

Steel Girder Bridges

1. *Polk County; Bridge Replacement- Steel Girder; I-35 (Westbound I-80) over 2nd Ave. at the North edge of the City of Des Moines (Letting: Jan. 6, 2000)*
2. *Polk County; Bridge Widening; On Merle Hay Road over Beaver Creek, just North of the I-35/I-80/Merle Hay Road Interchange (Letting: Mar. 24, 1998)*
3. *Polk County; Bridge Widening; Over Merle Hay Road, at the I-35/I-80/Merle Hay Road Interchange (Letting: Mar. 24, 1998)*

Concrete (PPCB) Bridges

1. *Grundy County; Bridge - New; U.S. 20 (Relocated) on Vista Avenue, over U.S. 20 just east of dike; (Letting: Dec. 1, 1998)*
2. *Grundy County; Bridge - New; U.S. 20 (Relocated) over county road T69; (Letting: Dec. 1, 1998)*
3. *Polk County; Bridge Replacement - PPCB; I-35 (I-80) Over NE 3rd St., east of 2nd Ave. at the North edge of the City of Des Moines; (Letting: Jan. 6, 2000)*
4. *Polk County; Bridge Replacement - PPCB; I-35 (I-80) Over NE 3rd St., east of 2nd Ave. at the North edge of the City of Des Moines; (Letting: Jan. 6, 2000)*
5. *Polk County; Bridge Replacement - PPCB; I-35 (Westbound I-80) (Westbound off ramp) Over NE 3rd St. at the 2nd Ave. interchange; (Letting: Jan. 6, 2000)*

6. *Polk County; Bridge New - PPCB; I-35 (Westbound I-80) Over Union Pacific RR at the east14th street interchange; (Letting: Jan. 6, 2000)*
7. *Polk County; Bridge Replacement - PPCB; I-35 Over Union Pacific RR, 0.3 km east of E. 14th St.; (Letting: Jan. 6, 2000)*
8. *Polk County; Bridge Replacement; I-35 (I-80) Over Union Pacific RR, 0.3 km east of the E. 4th St.(Letting: Jan. 6, 2000)*
9. *Polk County; Bridge Replacement - PPCB; I-35 (I-80) Over Union Pacific RR (two tracks), 1.0 km east of E. 14th St.; (Letting: Jan. 6, 2000)*
10. *Polk County; Bridge Replacement - PPCB; I-35 (I-80) Over Union Pacific RR (two tracks), 1.0 km east of E. 14th St.; (Letting: Jan. 6, 2000)*

The items within the contracts were entered into a Microsoft Windows Excel spreadsheet. Below in Table 2.1 is an example of one of the bridges and information used in the analysis.

Table 2.1. Polk County Steel Bridge on I-35 (Project number IM-35-3 (121) 85-13-77)

Item :	**Description**	**Unit**	**Quantity**	**Quantity per m^2**
2403-100010	Structural Concrete (Bridge)	m^3	326.30	0.23
2404-100100	Reinforcing Steel	kg	10,740.00	7.57
2404-100200	Reinforcing Steel, Epoxy Coated	kg	58,671.00	41.36
2408-100000	Structural Steel	kg	152,163.00	107.26
	Dual: 77.1 m x 18.4 m Continuous			
	Welded Girder Bridge			
	Area of Bridge	1,418.64	m^2	

A list of the item number and description are presented in Columns 1 and 2, respectively. Column 3 contains the units pertaining to each of the items listed in Column 2. Column 4 lists the quantities of material required for construction of each specified item in the contract.

Column 5 includes the factor per area of bridge deck. The factor or quantity per area (in metric units of meters squared (m^2)) was calculated by dividing the quantity of material (Column 4) by the specified area of bridge deck. The dimensions and an area of the bridge are listed just below the description of all items.

The factors are the quantities listed in the column designated as quantity per m^2. There are two reasons why the researcher selected the factors per unit area. First of all, the Iowa DOT currently uses the method of estimating project cost based on the area of bridge deck construction. The second reason was that the researcher believes material quantities can be estimated based on area of bridge deck. The analysis is applied here to determine whether a correlation between bridge area and estimating quantities of materials using factors (quantities per area) is appropriate.

A more detailed breakdown of each of the projects and factors is listed on page 50 for Steel Girder Bridges and pages 51 and 54 for PPCB Bridges. One will find each project identified by a project number, location of the project, and a letting date.

2.3 Material Factors

Prior to determining the factors to be used to estimate the quantities, the researcher set forth the following assumptions:

- All bridges used to estimate factors were of similar scope
- All bridges were of similar span
- All bridges were constructed of similar material (steel girder or PPCB)
- Construction time (season) was not considered in this analysis

- Only bridge deck area was considered in determining the factors to be used for material resource estimations

Based on the above assumptions, the factors (quantity per area) were calculated. The factors were calculated for the following resources:

- Structural Concrete (bridge)
- Reinforcing Steel
- Reinforcing Steel (epoxy coated)
- Structural Steel

Below is a table of all the factors per area for a specific item resource. Table 2.2 consists of three factors. All of the factors are in unit-per-area (m^2). Column 1 lists the item numbers according to the Iowa DOT designation. In Column 2, the description of each item is written. Column 3 designates the unit for each of the items. The remaining columns contain the factors for each bridge. The bridges listed in Columns 4 to 6 were discussed earlier in this chapter on page 11 and 12. The detailed information of the origin of each of the factors is presented on pages 50 to 54.

Similar procedure was followed to determine the PPCB Bridge factors for each resource item of used in the analysis. The items, the description of each and units as well as the factors are presented in the same formats as they were for Steel Girder Bridges.

Table 2.2. Factors for Steel Girder Bridges

Item	Description	Unit	Bridge 1 per m^2	Bridge 2 per m^2	Bridge 3 per m^2
2403-100010	Structural Concrete (Bridge)	m^3	0.23	0.29	0.37
2404-100100	Reinforcing Steel	kg	7.57	7.64	21.54
2404-100200	Reinforcing Steel, Epoxy Coated	kg	41.36	32.30	72.05
2408-100000	Structural Steel	kg	107.26	65.27	221.74

Listed in Table 2.3 are all of the factors for PPCB Bridges. There were a total of 10 factors that are in the form of unit-per area of bridge deck.

Table 2.3. Factors for PPCB Bridges

Bridge			1	2	3	4	5	6	7	8	9	10
Item	**Description**	**Unit**	**per m^2**	**per m^2**	**per m^2**	**per m^2**	**per m^2**	**per m^2**	**per m^2**	**per m^2**	**per m^2**	**per m^2**
2403-100010	Structural Concrete (Bridge)	m^3	0.46	1.04	0.28	0.28	0.48	0.48	0.16	0.15	0.34	0.34
2404-100100	Reinforcing Steel	kg	11.89	28.00	3.48	3.48	7.70	49.38	12.45	12.15	30.54	30.54
2404-100200	Reinforcing Steel, Epoxy Coated	kg	57.81	122.96	32.01	37.29	55.44	60.15	14.78	15.83	26.28	31.46
2408-100000	Structural Steel	kg	383.00	1.01				2.75	1.04	0.96	2.13	2.13

The researcher reviewed all of the factors and decided to use all factors to create one factor for each item of both steel and PPCB Bridges. The reason that all of the factors (to determine the final average factor) were selected was because of the close range of values. The researcher concludes that the use of all values of factors will best represent the estimated value of the average factor.

These factors were based on area of deck and quantities listed within the contract. Plans of each project were not provided for the process of determining the factors. Therefore, and estimate for the material in the bridge example of piers was already included in the quantities. Since the amount of material in the bridge piers is variable, variability in factors exists.

2.4 Application of Factor on I-235 Bridges

Now that the factors were calculated, the effectiveness was tested. The conceptual estimating method factors were applied to estimate the I-235 bridge material resources. These estimates were compared to actual quantities from detailed plans.

The following bridges were selected for the analysis part of this thesis. The bridges were selected because the Iowa DOT provided preliminary or final quantity summary sheets for these bridges. The quantities provided by the Iowa DOT were then used as a reference to demonstrate the application and effectiveness of using the factor to estimate resources. These bridges are:

Steel Girder Bridges:

- Cottage Grove
- East 6th Street
- East 9th Street
- University Avenue Ramp
- Easton Road

PPCB Bridges:

- 42nd Street in West Des Moines
- 28th Street in West Des Moines

To further establish the effectiveness or ineffectiveness of using the factors, the researcher selected three factor ranges for each of the items discussed earlier.

In order to find the possible range of estimated quantities, the researcher used the low factor, the average factor, and the high factor value. The low value factor was established by selection of the lowest value of all of the factors in Table 2.2 and Table 2.3 for each item (steel and concrete) of respective bridges. Similarly, the high value factor was established by a selection of the highest value of all of the factors in the Tables 2.2 and 2.3 for each item and respective bridge types. The average value factor was established as the mean value of all the factors for each item. Once again, the factors for Steel Bridges were used to estimate Steel Bridge material quantities on I-235 and similarly the PPCB Bridge factors were used to estimate the material quantities used to construct the PPCB Bridges on I-235. In Table 2.4, an example of Cottage Grove Bridge is presented to demonstrate the overall format and results of the application of factors.

Table 2.4. Estimated Quantities (based on calculated factor) of Cottage Grove Bridge

Item	Description	Unit	per m^2 Low	per m^2 High	per m^2 Average	Quantity Low	Quantity High	Quantity Average
2403-100010	Structural Concrete (Bridge)	m^3	0.23	0.37	0.30	337.62	546.06	435.97
2404-100100	Reinforcing Steel	kg	7.57	21.54	12.25	11,113.47	31,622.97	17,984.71
2404-100200	Reinforcing Steel, Epoxy Coated	kg	32.30	72.05	48.57	47,408.77	105,768.07	71,294.44
2408-100000	Structural Steel	kg	65.27	221.74	131.42	95,803.96	325,490.68	192,911.42

The results of the analysis of the data are located on page 55 and 56 for steel bridges and page 57 for PPCB bridges. The data in the above table is presented in similar format as previous tables discussed in this chapter. Each bridge is described in detail with station number, dimensions, and bridge spans. The bridge material is designated with an item number, a description of the item, and units pertaining to each item. The remaining data in the table are the factors (with respective range) and quantities estimated. The dimensions of the bridges to be constructed on I-235 are known and were multiplied by all the respective factors to estimate quantities based on these factors.

The factors, as already discussed, are categorized as low, high, and average. Similarly, columns with quantities are labeled respectively in reference to the factor used to calculate the resource quantity. This means that the columns labeled as "Quantity" are the result of a multiplication of an area by a factor corresponding to a previous column. Therefore, "Quantity Low" is the product of an area multiplied by a factor of (per square meter) of the "Low" column. The resulting quantities based on the computed factor give one an idea of the possible amount of material needed. The final quantities then will be compared with the quantity provided by the Iowa DOT.

2.5 Applying the Factors

Now that the estimated quantities are calculated, the question is what do we do with this information? What does this tell us? The range of estimated values for the structural PCC, reinforcing steel (non-epoxy and epoxy coated) and structural steel have been estimated. Now comes the real test. Are the estimated values within a reasonable range to be considered for the application of factors on I-235? Quantities for the four items mentioned above for the 5 steel and 2 PPCB bridges proposed for construction on I-235 are on pages 58 and 59 for Steel Bridges and page 60 for PPCB Bridges. Table 2.5, as an example, contains the proposal quantities for the Cottage Grove Bridge on I-235.

Table 2.5. Cottage Grove Resource Quantities Proposed in the Plans

Item :	Description	Unit	Quantity (in Proposal)
2403-100010	Structural Concrete (Bridge)	m^3	178.50
2404-100100	Reinforcing Steel	kg	29,720.00
2404-100200	Reinforcing Steel, Epoxy Coated	kg	171,076.00
2408-100000	Structural Steel	kg	559,000.00

2.6 The Comparison

The results of the estimated (by factor) quantities and the actual (proposal) quantities of material differed with the analysis and approaches applied. Since the factor alone had a wide range of possibilities, the results estimated present such a range. The researcher set a guideline for the analysis. The guideline involved a possible pattern that exists among the actual and estimated resource quantities. A review of all of the estimates both from the factors and quantities provided by Iowa DOT did present a pattern. The researcher concluded that even though some material quantities (as estimated by the use of a factor) were within range of the proposal quantities, the method of using factors applied in this analysis will not provide an acceptable estimate.

In Table 2.6 (Cottage Grove Bridge) and Table 2.7 (42nd Street Bridge), the comparison among the calculated (by factor) quantities and the proposal quantities is presented. The researcher indicated the range of the comparison in the column farthest to the right in the tables. The comparison, as mentioned earlier in this chapter, was made between the estimated (based on factors) and the actual (proposal) quantities provided by the Iowa DOT.

Table 2.6 Cottage Grove Bridge Quantity Comparisons

Item	Description	Unit	Quantity (in Proposal)	Quantity from Factors			Comparison of Proposal to Factor Quantity
				Quantity Low	Quantity High	Quantity Average	
2403-100010	Structural Concrete (Bridge)	m^3	178.50	337.62	546.06	435.97	Below Low
2404-100100	Reinforcing Steel	kg	29,720.00	11,113.47	31,622.97	17,984.71	Between Average and High
2404-100200	Reinforcing Steel, Epoxy Coated	kg	171,076.00	47,408.77	105,768.07	71,294.44	Above High
2408-100000	Structural Steel	kg	559,000.00	95,803.96	325,490.68	192,911.42	Above High

Table 2.7. 42nd Street Bridge Quantity Comparisons

Item	Description	Unit	Quantity (in Proposal)	Quantity from Factors			Comparison of Proposal to Factor Quantity
				Quantity Low	Quantity High	Quantity Average	
2403-100010	Structural Concrete (Bridge)	m^3	32.80	101.61	716.08	275.79	Below Low
2404-100100	Reinforcing Steel	kg	10,747.00	2,404.68	34,130.07	13,104.46	Between Low and Average
2404-100200	Reinforcing Steel, Epoxy Coated	kg	59,920.00	10,215.24	84,989.26	31,380.48	Between Average and High
2408-100000	Structural Steel	kg	7,337.00	699.49	264,729.60	38,808.81	Between Low and Average

2.7 Conclusion

The derivation of the factor was limited by the information that was not included in the contracts. The factors calculated using this research method would not always provide the exact quantities needed to complete a project. The estimated quantity of materials did not match the proposal quantities for any of the bridges. Such variability at first was assumed to be correctable; compensating for the error by applying an additional 5 to 10 % of quantity of material. This approach could only be applied if the comparison among all the bridges presented a clear pattern where the factor was, for example, the use of a low for concrete or average for the steels. Any combination as long as the same level of factor appeared on Steel Girder and PPCB bridges, respectively. The factors here are based on the area of the bridge deck. The final quantities are a reflection of only bridge deck area.

The process of resource loading as mentioned before is quite time consuming. The method that was developed here attempted to minimize the amount of time required to estimate quantities when the designs are not complete. Although this analysis did present a very rough estimate, additional information other than just bridge deck area is needed. A more detailed schedule and method of construction could be derived if the researcher was provided with plans for each of the contracts. The factors would be more comparable and possibly correlate better with the quantities in the proposal.

CHAPTER 3: CONCEPTUAL QUANTITY TAKEOFF OF CONCRETE / ASPHALT / FENCE

3.1 Introduction

The supply of materials such as aggregate and steel can become limited. At the present time, the Iowa DOT has provided a projected plan of construction for the 10 sections on the I-235 corridor. A more in-depth analysis is required to find if the required amount of material is available to construct bridges, ramps, and the mainline roadway. A conceptual quantity takeoff has been performed based on the bridge and roadway design. The material resources that are the focus of this chapter are: PCC and ACC and the breakdown of the material by the design mix. The chain-link fence placed on the bridges will also be reviewed and discussed as a material resource in the next section.

3.2 Material Availability

The state of Iowa has a limited number of sources that can or are able to provide the aggregate for base or for production of concrete and asphalt (SUPERPAVE) mix for both bridge and pavement on the mainline. A similar situation arises with the production of steel. Fabrication time for steel, according to the Iowa DOT engineers, ranges from 3 to 8 months. The time of fabrication is dependent on the demand of the industry. The fabrication time can become extended if the demand increases. Slow delivery of material could hinder the construction schedule.

In the process of preparing for such a large construction project material production facilities in the area must be informed. The more information that the Iowa DOT has about the future demand for material, the more likely that such material will be delivered in time to complete a section of the roadway or bridge deck because material producers will have an opportunity to prepare. A more in-depth discussion of facilities that supply these resources to the contractor will be addressed in a future section of this chapter.

3.3 Mainline PCC and ACC Quantity Takeoffs

3.3.1 Cross Sections

Resource calculations on the 14-mile mainline corridor were estimated using the conceptual plans provided by the Iowa DOT. See Figure 3.1 for the layout of the entire corridor and the labeled designation of each of cross-section's beginning and end. The 14-miles of I-235 was partitioned into four typical cross sections. Each cross-section includes PCC, ACC and granular base material. Volumes of each material (as solid) were calculated.

Drawings identifying each of the four typical cross-sections are located on page 62 to 65. Based on the typical included in the appendix, material quantities were calculated. For a detailed procedure of how the material was calculated based on the cross-section typical provided by the Iowa DOT, see pages 66 to 72.

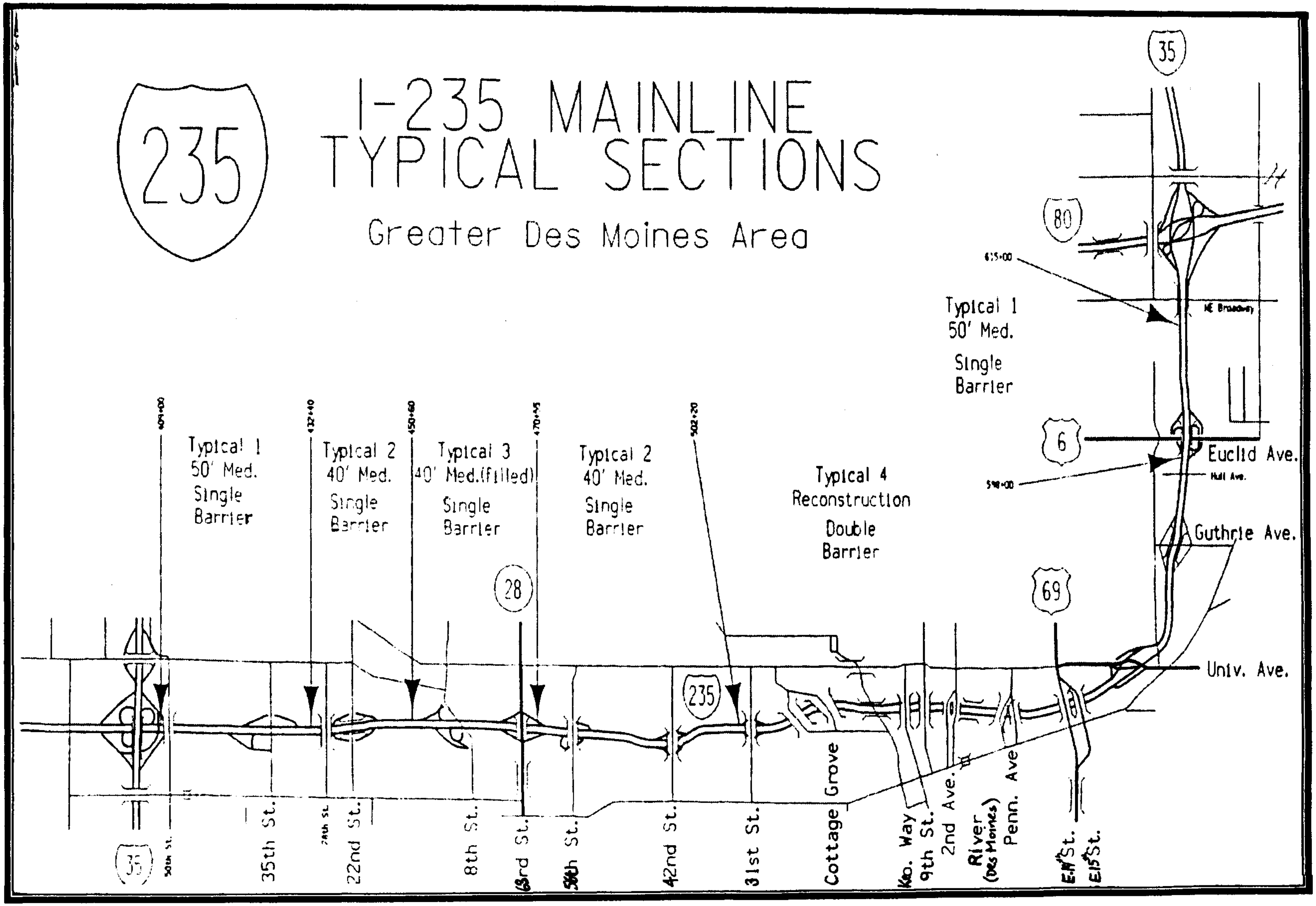


Figure 3.1 Layout of the location of the four cross-sections typical on I-235 (Iowa DOT)

3.3.2 Mix Designs

The mix design for PCC on the mainline of I-235 is C-3WR with 6% (i.e. 6% by volume) air entrainment. The design means that the following are percentage breakdowns of material for the design:

- Air-entrained 6.0%
- Cement 10.8 %
- Water 14.6%
- Fine Aggregate 30.9%
- Coarse Aggregate 37.7%

The Iowa DOT also specified that 35% of the cement in the mix design should be substituted with slag and fly ash. This means that 3.78% will be fly ash and slag and 7.02% is to be cement. More details on the slag and fly ash availability in the state of Iowa will be explained later in this chapter.

The mix design for PCC on the bridge decks along I-235 is C-4WR with a 6% air entrainment. The mix is composed of the following percentages of material:

- Air-entrained 6.0%
- Cement 11.2%
- Water 15.1%
- Fine Aggregate 33.9%
- Coarse Aggregate 33.8%

Similarly, as for the mainline mix of PCC, the Iowa DOT specified that 35% of the cement is to be substituted with slag and fly ash. Therefore, 3.92% will contain the substitute of slag and fly ash, and remaining 7.28% will be cement

The ACC mix design was only specified as SUPERPAVE. The researcher created a mix design with 4.0% air voids to determine the amount of aggregates and ACC binder required. The mix design consists of the following breakdown of material:

- Voids 4.0%
- ACC Binder 8.0%
- Aggregate (Fine and Coarse) 88.0%

All of the takeoffs and the materials breakdown are based on the above mentioned mix designs and typical cross-sections for bridge deck, mainline PCC paving, and mainline ACC paving.

3.4. Material Breakdown of PCC

The bridge thickness was estimated as 0.31 m (12 in.). A typical bridge deck thickness is 8 inches. Also, the considered calculations were based on a density of 150 pounds per cubic foot of material. Total breakdown of material on the bridge decks is: slag and fly ash of 1,365 Tons (English Tons) or 1,238 Mega grams (Mg), cement of 2,535 Tons (2,300 Mg), fine aggregate of 11,806 Tons (10,710 Mg), and coarse aggregate of 11,771 Tons (10,678 Mg). Table 3.1 lists the year, volume and the breakdown of the material that comprises the C-4WR. For a detail of the bridge decks and their locations see page 73.

For the mainline, PCC quantities were calculated based on the typical and mix design specification. The total amount of slag and fly ash is 9,837 Tons (8,924 Mg); cement 18,268 Tons (16,572 Mg), fine aggregate 80,410 Tons (72,947 Mg) and coarse aggregate 98,106 Tons (89,000 Mg). All quantities in Table 3.2 are based on a density of 150 pounds per cubic foot of material.

Table 3.1. PCC Bridges Deck Material Breakdown (by Volume)

C-4WR Mix
Design

			% of material (6 % air entrained)				
Bridge deck	**Year**	**Volume (m^3)**	**Slag or Fly ash substitute (35% of cement 10.2% = 3.92%)**	**Cement 7.28%**	**Water 15.1%**	**Fine Aggregate 33.9%**	**Coarse Aggregate 33.8%**
1	2003	686	27	50	104	233	232
2	2002/2005	292	11	21	44	99	99
3	2002/2005	66	3	5	10	22	22
4	2003/2005	223	9	16	34	76	75
5	2003	389	15	28	59	132	131
6	2002	556	22	40	84	188	188
7	2003	465	18	34	70	158	157
8	2002	408	16	30	62	138	138
10	2004/2005/2006	4,873	191	355	736	1,652	1,647
11	2003	614	24	45	93	208	208
12	2004	591	23	43	89	200	200
13	2003	240	9	17	36	81	81
14	2004	455	18	33	69	154	154
15	2003	360	14	26	54	122	122
16	2002	641	25	47	97	217	217
17	2003	422	17	31	64	143	143
18	2002	468	18	34	71	159	158
19	2002	672	26	49	101	228	227
21	2002	194	8	14	29	66	66
22	2002	278	11	20	42	94	94
24	2002	257	10	19	39	87	87

Total	**13,150**	**515**	**957**	**1,986**	**4,458**	**4,445**	**m^3**
	34,825	**1,365**	**2,535**	**5,259**	**11,806**	**11,771**	**Tons**
	31,593	**1,238**	**2,300**	**4,771**	**10,710**	**10,678**	**Mg**

Table 3.2. Mainline PCC Material Breakdown (by Volume)

Mix Design: C-3 WR			% of material (6 % air-entrained)			
		Cement and substitutes: 10.8%				
Roadway Section	Volume (m^3)	Slag or Fly ash substitute (35% of cement = 3.78%)	Cement 10.8%: w/o sub. = 7.02%	Water 14.6%	Fine Aggregate 30.9%	Coarse Aggregate 37.7%
1-3	1,536	58	108	224	475	579
4	1,347	51	95	197	416	508
5	35,237	1,332	2,474	5,145	10,888	13,284
6	30,877	1,167	2,168	4,508	9,541	11,641
7	18,648	705	1,309	2,723	5,762	7,030
8-10	10,617	401	745	1,550	3,281	4,003
Total	**98,262**	**3,714**	**6,898**	**14,346**	**30,363**	**37,045 m^3**
	260,228	**9,837**	**18,268**	**37,993**	**80,410**	**98,106 Tons**
	236,074	**8,924**	**16,572**	**34,467**	**72,947**	**89,000 Mg**
Area	**316,974**	**11,982**	**22,252**	**46,278**	**97,945**	**119,499 m^2**

3.5 Slag and Fly Ash

All bridge decks and sections of the mainline on I-235 will be constructed of PCC. Two mix designs were selected. The mix designs for bridge decks are C-4RW and for mainline pavement C-3WR. The designs allow 35% of the cement to be substituted with fly ash and slag. The amount of fly ash and slag that is required to construct the mainline is 9,838 Tons (5,925 Mg) and is 1,365 Tons (1,238 Mg) for the bridge decks as discussed earlier. The required amount of slag and fly ash is presented in Table 3.1 for bridge decks and for mainline in Table 3.2 See pages 74 to 75 for the breakdown of mainline materials by section and year of construction.

The state of Iowa has 4 plants that produce fly ash. Listed below are the locations of the plants and the yearly production of fly ash:

Location		Production in thousand tons per year	
Council Bluffs		100	
Lansing		25	
Louisa		100	
Ottumwa		100	(75 nominal)
Muscatine		14	
Clinton		50	
Port Neal (2)		40	
Port Neal (3)		60	
Port Neal (4)		100	
	Total	~590	

The overall quantities for the mainline and bridge decks is estimated at 11,200 tons of slag or fly ash. Therefore, the above plants produce sufficient amount of material to meet the demand for fly ash for I-235 construction. Even though it appears that the demand can be met, 35% of cement content cannot be fly ash. A reasonable maximum of fly ash to cement substitution is around 15%. Quantities greater than 15% will result in a very poor mix design. The mix design, according to the Portland Cement Institute standards, will not meet the desired strength and design specifications.

Slag is required in the current mix design, however it is not produced in Iowa. The Iowa DOT should begin to release information to suppliers about the potential demand for slag. If the material is not available at time of construction delays and increased project costs could result. The researcher suggests that an alternative would be to change the mix design of the PCC so that it does not require the desired 35 % substitution of cement with slag and fly ash.

3.6 Asphalt Quantities

Sections of I-235 mainline as well as interchange designs will be constructed of ACC material. The researcher took the initiative to calculate preliminary quantities. The ACC mix design was selected as containing 88% of aggregate, 8 % of ACC binder, and 4 % air-voids. The total asphalt as it was calculated from the mainline typical was 566,841 Tons (514,229 Mg) by volume. Table 3.3 lists the breakdown by volume for each section of I-235.

Table 3.3. Mainline Asphalt Material Breakdown (Totals)

Roadway Section	Volume (m^3)	Air Voids (4%)	Binder (8%)	Aggregate (88%)	
1-3	86,375	3,455	6,910	76,010	
4	79,113	3,165	6,329	69,619	
5	-	-	-	-	
6	-	-	-	-	
7	-	-	-	-	
8-10	48,551	1,942	3,884	42,725	
Total	**214,039**		**17,123**	**188,354**	**m^3**
Total (Tons)	**566,841**		**45,347**	**498,820**	**Tons**
Total (Mg)	**514,229**		**41,138**	**452,521**	**Mg**

The majority of ACC paving will be executed in years 2005 and 2006. The year that is of greatest concern is the year 2005 when a total of 43,157 Tons (39,152 Mg) of ACC binder and 474,728 Tons (430,673 Mg) of aggregate will be required. In Table 3.4, ACC quantities are listed according to year of construction.

Table 3.4. Total ACC Placed on Mainline (by Year)

Year	Binder (Tons)	Aggregate (Tons)	Total (Tons)
2005	43,157	474,728	**517,885**
2006	2,191	24,094	**26,285**
Total (Tons)	**45,348**	**498,822**	

An average production rate of placing ACC is 1500 Tons per day. The production rate is an average rate proposed by the Iowa DOT. Based on the amount of material specified for the year 2005 and the production rate stated, the construction is not feasible. A total of 340 days would be required to place the estimated ACC for the year 2005. Production of placing the material must be increased. The option of paving mainline in year 2004 or sooner is nor possible. The paving would be in conflict with the bridge constructions. See page 76 for the details and the breakdown of material by year and sections. The researcher suggests that the Iowa DOT release preliminary material quantities required for reconstruction of mainline ACC pavement. This can be a long-term advantage to the contractors as well as the completion of I-235 projects for the projected year of 2006.

3.7 Quantity Totals

The takeoff quantities of both PCC and ACC were based on plans provided to the researcher by the Iowa DOT. The quantities indicate that the overall material requirement for bridges (Table 3.6) on I-235 listed earlier and mainline pavement (Table 3.7) consist of the following breakdown in material:

Table 3.5 Total Bridge PCC

Year	Fly ash and Slag (Tons)	Cement (Tons)	Fine Aggregate (Tons)	Coarse Aggregate (Tons)	Total (Tons)
2002	379	705	3,277	3,266	**7,627**
2003	341	633	2,953	2,944	**6,871**
2004	278	515	2,398	2,391	**5,582**
2005	199	369	1,719	1,715	**4,002**
2006	169	313	1,458	1,454	**3,394**
Total (Tons)	**1,366**	**2,535**	**11,805**	**11,770**	

Table 3.6 Total Mainline PCC

Year	Fly ash and Slag (Tons)	Cement (Tons)	Fine Aggregate (Tons)	Coarse Aggregate (Tons)	Total (Tons)
2003	448	832	4,468	3,662	**9,410**
2004	720	1,337	7,179	5,884	**15,120**
2005	4,789	8,894	47,763	39,148	**100,594**
2006	3,881	7,205	38,697	31,716	**81,499**
Total (Tons)	**9,838**	**18,268**	**98,107**	**80,410**	

3.8 Fence Resource

The Iowa DOT saw a need to provide an aesthetically appealing bridge to commuters while providing a safety net for pedestrians crossing the interstate via the many bridges to be constructed in the next 4 years. So the Iowa DOT designed fence for placement on the bridge rail next to proposed pedestrian sidewalks. The researcher estimated lengths of this chain-linked fence. The estimated quantity of fence required per length of bridge is based on the as stated length of a bridge. The estimates for the quantity of fence required per bridge are listed for 23 bridges in Table 3.7. The overall quantity of fence required is 2700 meters.

The highlighted bridges will be used to compare these to the list of fence quantities provided by Iowa DOT. The Iowa DOT proposed a plan and design of the chain-linked fence for 7 bridges for which construction will be completed either this or next construction season.

Fence estimate sheets included in the plans packet indicate the proposed bridges where the new fence will be installed (See page 77). The values determined by the researcher are 10 percent (%) less than the values provided by the Iowa DOT. The reason for the variation

Table 3.7 Bridge Fence Estimates

Section	Bridge	Type	Quantity	Length (m)	Total Length (m)
Sect. 1-3	50th St. (WDSM)	PPCB	1	104.00	104.00
	42nd St. (WDSM)	PPCB	1	76.80	76.80
	35th St. (WDSM)	PPCB	1	73.75	73.75
	28th St. (WDSM)	PPCB	1	82.90	82.90
Sect. 4	63rd. St.	PPCB	2	76.80	153.60*
	56th St.	PPCB	0	0.00	0.00*
	Polk Blvd.	PPCB	2	61.50	123.00
	42nd St.	PPCB	1	82.90	82.90*
	31st. St.	PPCB	2	76.80	153.60*
Sect. 5	Cottage Grove	Steel	1	116.50	116.50
	MLK	Steel	2	83.90	167.80
	19th St.	Steel	1	68.10	68.10
	9th St.	Steel	2	94.00	188.00
	7th St.	Steel	2	71.70	143.40
	6th Ave.	Steel	2	74.10	148.20
	3rd St.	Steel	1	95.30	95.30
	2nd Ave.	Steel	1	110.00	110.00
Sect. 6	E. 6th St.	Steel	1	87.70	87.70
	Penn Ave.	Steel	1	100.00	100.00
	E. 9th St.	Steel	2	130.00	260.00
	E. 12th St.	Steel	2	91.00	182.00
	E. 14th St.	Steel	1	76.80	76.80*
Sect. 8	Euclid Ave.	Steel	1	92.20	92.20
				TOTAL	**2687 m**

* Indicated estimated quantity (no plans are provided) based on the staging plans

in the resource quantities is due to the limited scope of information available to the researcher at the time of the takeoff analysis.

The researcher only considered the bridge length as the reference to estimate fence resources. In the researcher's opinion the estimates are sufficient to provided preliminary quantities prior to the issuance of design and bid to the contractors.

3.9 Conclusion

The fly ash producers of Iowa can meet the demand for 1,365 Tons of fly ash. The majority of the PCC resources will be used to reconstruct mainline I-235, interchanges and ramps. The quantities of PCC and ACC calculated on the mainline were based on the typical cross-sections. The construction years were selected as specified by the Iowa DOT staging plans. Based on the quantities estimated for ACC (composed of SUPERPAVE mix design), the production of the placement would have to be increased to complete the paving for the year 2005.

The PCC quantity takeoffs were only calculated for the specified bridges in the tables. The remaining bridge material quantities will be calculated as the Iowa DOT provides the preliminary bridge deck plans. Since materials are critical to the progress of the construction, constant monitoring and updating must be performed as new information is provided, and changes in mix designs or staging occur.

CHAPTER 4: INSPECTORS

4.1 Introduction

Resourcing does not necessarily pertain to only materials. In this instance, the focus shifts to labor and particularly inspectors. The inspector's job is to check on the progress as well as construction of a project. The inspector makes sure that the contractor constructs everything according to the design plans. The inspector documents the means, methods, and quantities installed on the construction project. Should questions arise about the process or design, the contractor can directly relate all questions to the inspector. For the above-mentioned reasons, the construction of a project without inspectors cannot occur. Inspectors are a must. Inspectors play a vital role in assuring the owner that the construction was performed in accordance with the specifications. In this instance, the owner is the Iowa DOT.

Inspectors contribute greatly to the process was well as the outcome of a project. The Iowa DOT must be prepared to oversee the construction of projects directly at the construction site. This requires having the adequate resource of labor (inspecting engineers) to be placed on the projects. The assigning of inspectors for this particular project required, in the researchers opinion, considerable thought and understanding of the projects involved.

4.2 Assigning Inspectors

The researcher used two approaches to estimate the number of required inspectors. The first approach addressed the estimation of inspectors by applying information gathered from the Iowa DOT. The second approach combined projects of similar construction and that were in proximity to each other.

The researcher contacted an engineer (Kevin Merryman) at the Iowa DOT who had the background and direct knowledge of what is involved in assigning inspectors on construction projects. According to the engineer, a typical project requires the following number of inspectors based on the specified type of construction:

Number of Inspectors	Type of Construction
1	Bridge
2 to 3	Grade and Pave
1	Culvert
1	Noise Wall

Based on the above set criteria, inspectors were estimated for the entire construction corridor of I-235. Inspectors were estimated for each year beginning with 2002 and ending in 2006.

Below is the summary of the inspector resource required for each year of construction. For further details of exact location of inspectors, the number of inspectors per project, the type of project inspected and the year when the project will be constructed see pages 79 to 80.

Year	Number of Inspectors
2002	18
2003	32
2004	49
2005	48
2006	30

A distribution according the number of inspectors for each year of construction is presented in Figure 4.1. The distribution shows the peak demands of inspectors required. The total of 117 inspectors does not necessarily mean that there is a demand for that many inspectors.

The 117 is the overall total of all of the inspectors that would be needed on I-235 from 2002 to 2006 should all projects last longer than one construction season.

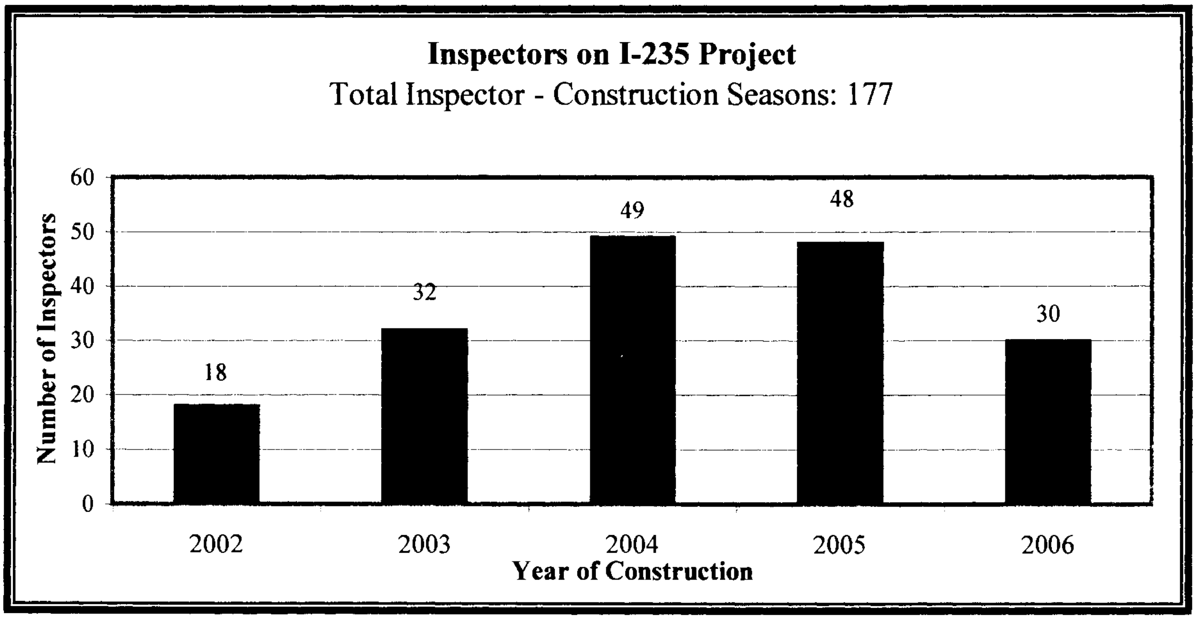


Figure 4.1 Inspector Distribution Based on Iowa DOT Information

The results indicated that years 2004 and 2005 would have the highest requirement. The reason for such a high demand of inspectors is directly related to the quantity of projects under construction. Iowa DOT does not have the adequate manpower to assign this number of qualified inspectors. The estimated inspector quantities for this first approach did not take into consideration the possibility that an inspector can undertake inspection of more than one project. Therefore, a second approach was applied to reduce the number of inspectors required on the project.

The second approach addressed the combining of inspector duties on two or more adjacent projects that are constructed in the same construction season. Below are the results involving the sharing of inspectors between projects for each year of construction.

Year	Number of Inspectors
2002	12
2003	24
2004	31
2005	33
2006	21

In Figure 4.2, the distribution focuses on the sharing of inspectors. Similarly as discussed in the above approach, the total in this instance of 121 inspectors is only the overall total should each of the projects continue to the next construction season.

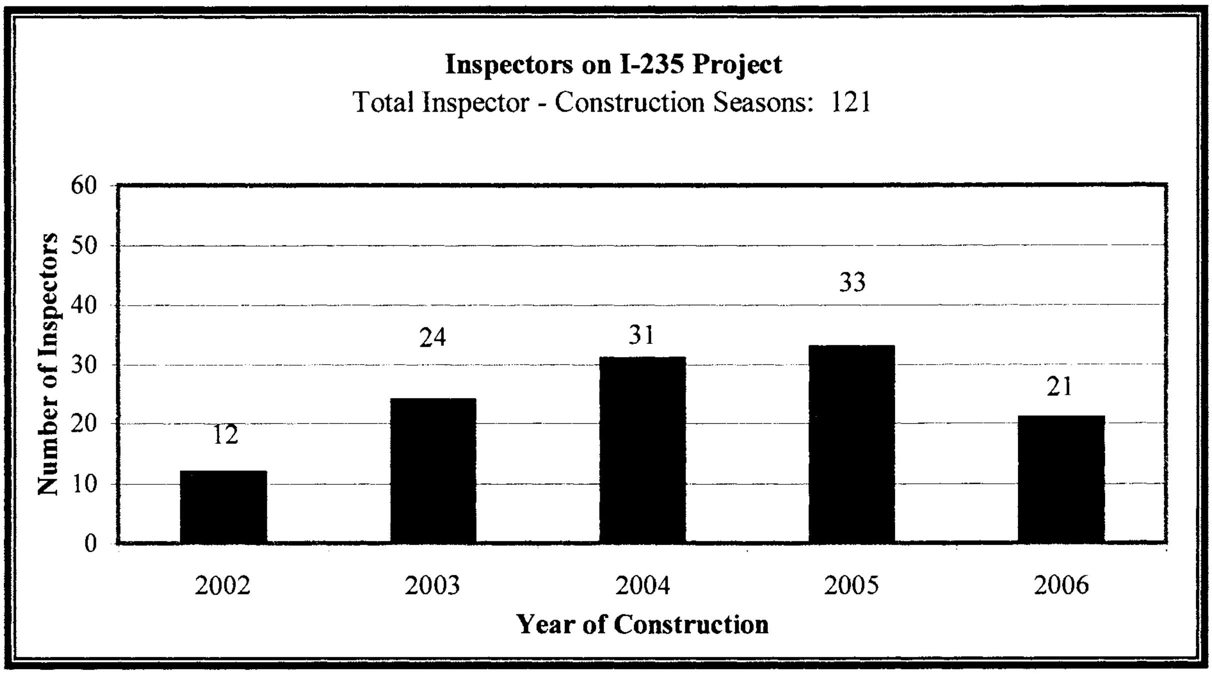


Figure 4.2 Inspector Distribution Based on Sharing

See pages 81 to 82 for a more detailed listing of the estimated number of inspectors, the type of project inspectors were assigned for sharing, and year of construction. Similar results occurred as in the first approach. Both approaches resulted in having a higher demand for inspectors in years 2004 and 2005; however, the number of inspectors needed for assignment assigned is reduced. This minimizes the need of hiring individuals that would have to be placed on a project and committed to the construction for the entire time.

4.3 Conclusion

The versatility of having an inspector oversee more than one project will minimize the quantity of inspectors on I-235. The two approaches applied here present many advantages when it comes to estimating inspectors. The advantages include having a quick method of estimating, addressing the desires of the owner, and minimizing the possibility of delay because of a shortage of inspectors.

A project of similar scope and demand as I-235 will present a need to estimate inspectors. An owner, as in this instance, the Iowa DOT desires to know how many inspectors are needed. When applying the second approach an individual should evaluate the project and carefully review the sharing of assigned inspectors for that particular project. One should evaluate which inspector duties are complimentary in performance when assigning an inspector to more than one project. Simultaneous or non-complimentary inspection duties would cause a reduction of efficiency and quality. Therefore, a need exists to resource labor carefully to prevent such an instance from occurring.

CHAPTER 5: COST RESOURCING

5.1 Introduction

Resourcing cost is as important as resourcing material. The Iowa DOT planned/scheduled the construction of the I-235 project based on fund availability. Funds designated for construction control the year of the actual construction of a project. The Iowa DOT has designated $426 million to be spent during the 4 years on the entire I-235 construction. The DOT also estimated the cost of each individual project by using cost data from previous projects constructed in the area. They estimated the cost for bridges based on square footage of the bridge. The cost of the structures was estimated by the Iowa DOT at a cost of $75 per area constructed.

In the recent months the Iowa DOT has let 3 projects for construction. The actual cost as submitted in the contractor's bids came in at twenty to twenty-five percent above the proposed cost estimated by the Iowa DOT. A more in-depth evaluation of why the costs are higher than expected, how the higher cost will affect the construction and ways to constrain the construction to the proposed budget must be reviewed.

5.2 Proposed Budget Breakdown

The Iowa DOT as described in previous chapters has sectioned the 14-mile corridor of I-235 into 10 individual sections. Data related to the construction of I-235 has been placed on a Microsoft Project Schedule with designations according to the sections specified by the Iowa DOT. An Iowa StateUniveristy graduate student in charge of scheduling has continuously updated all data such as the location of the projects, the letting dates for each project, the proposed costs and the actual costs. The recording of cost information on the scheduling program has provided the researcher the capability to review the project budget. Table 5.1 specifies the proposed cost of construction of the projects by section.

Table 5.1. Proposed Cost Summary by Section

Location (Section)	Cost in Millions
Sec 1-3:	33.49M
Sec 4:	47.93M
Sec 5:	57.87M
Sec 6:	26.73M
Sec 7:	35.09M
Sec 8-10:	12.23M
General Activities:	212.66M
Total:	**426.00M**

The researcher reviewed the possibility of cost increases based just on the three projects already let. According to the bids proposed by the contractors and accepted by the Iowa DOT, the cost per area appears to have increased by an estimated $75 to $100. Keeping that in mind, Table 5.2 presents the cost of the project (designated by section) if all future bids were to come in at twenty percent above the projected construction cost. The results indicate an increase of $85 million in the budget from the proposed cost to construct the entire I-235.

Table 5.2. Estimated Cost Summary by Section

Location (Section)	Cost in Millions
Sec 1-3:	40.19M
Sec 4:	57.52M
Sec 5:	69.44M
Sec 6:	32.08M
Sec 7:	42.11M
Sec 8-10:	14.68M
General Activities:	255.19M
Total:	**511.20M**

5.3 Designated Cost Per Project

The overall costs designated in Table 5.1 were determined by combining all areas under construction during the 4-years of the I-235 reconstruction. The cost includes the construction of bridges, interchanges, widening of the mainline and the installation of utilities. A more detailed breakdown of the costs presented in the tables is located on page 84 to 94, specified by the type of project, the letting date, and the proposed cost per location in designated sections. As previously mentioned, the data is continuously being updated as projects are let and new costs are provided by the Iowa DOT.

5.4 Cost Per Year

Based on the available costs (as provided by the Iowa DOT) and the designated letting dates, the researcher created a cost versus time curve, see Figure 5.1.

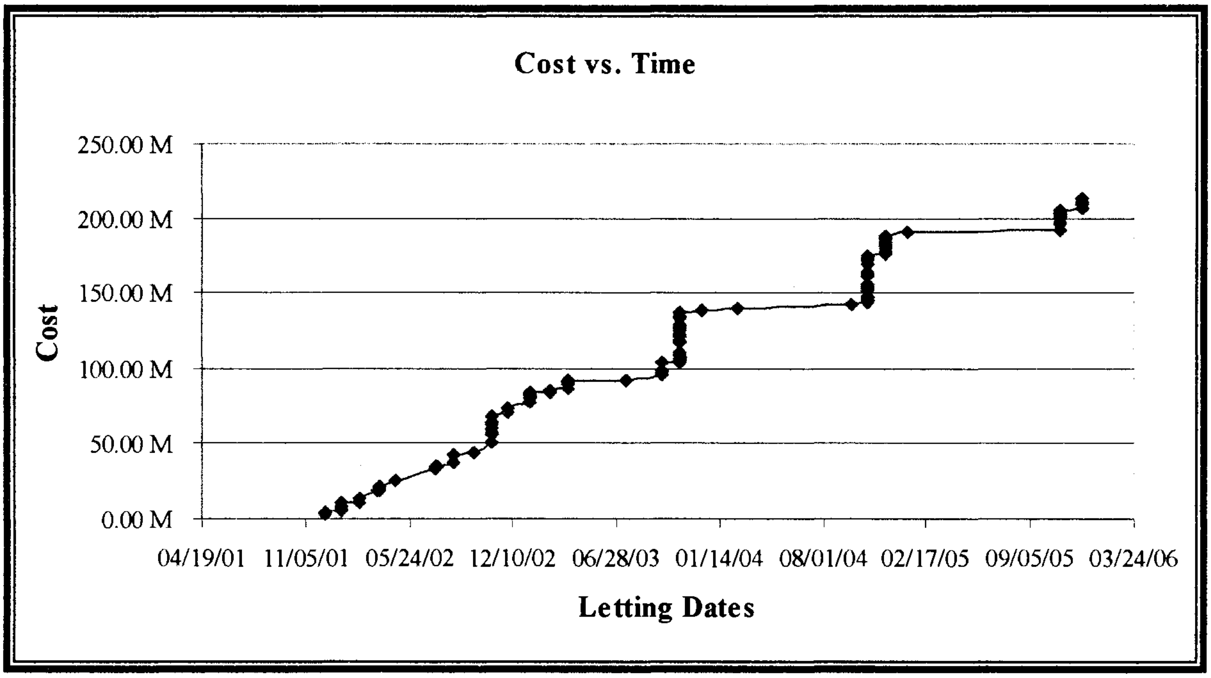


Figure 5.1 Cost vs. Time Curve (by letting dates)

The curve presents a progressive increase in the cost of the entire project with time of construction. Not all of the entire $426 million is placed on the curve. The reason is that at the time of the writing of this thesis, only $213 million (about half of the amount) of cost was established and designated according to the letting dates.

The costs from the curve were further categorized according to the fiscal year. This means that for budgetary purposes, the Iowa DOT has a set date when the beginning of budget fiscal year begins and ends. In other words, the 2002 fiscal year begins on July 1, 2001 and ends on June 30, 2002. A breakdown of the $213 million (half of the proposed $426 million) budget is presented in Table 5.3.

Table 5.3. Cost Categorized by Fiscal Year

Fiscal Year	Cost
2002	25.26M
2003	66.25M
2004	47.78M
2005	50.52M
2006	23.17M
Total	**213.20M**

Various reasons suggest that the cost of a project of this magnitude must be broken down not just according to section, but also year of construction. One reason is limited funding and another reason is source of funding.

5.5 Conclusion

The method of tracking the cost of construction is very important to the flow and stability of not just Iowa DOT but also roadway construction. The Iowa DOT has limited funding. Funding for a project like this comes from various agencies depending on the type of construction performed. The Iowa DOT must be informed of proposed costs as well as increased costs to construct I-235 in the years planned. Similarly, as with resource materials or labor, if monies to fund the construction are not available, limited projects will be let. Therefore, projects that are delayed due to lack of funding in the current fiscal year subsequently increase the cost of future projects because of increases in material and labor costs.

Issues associated with an increase of the proposed $426 million must also be addressed. Should the actual cost exceed that of the proposed cost, the Iowa DOT has two alternatives. One is to increase the budget to fund the construction. If increases in the budget are not possible, another alternative is to extend the construction schedule by changing the final finishing date from 2006 to a more satisfactory and feasible completion date.

CHAPTER 6: SUMMARY / RECOMMENDATIONS / IMPLEMENTATION

6.1 Summary

Providing necessary materials, funding, and personnel on a timely basis, is critical to the timely completion of a project. The researcher spent considerable time gathering appropriate data to assess this process. Combined with gathering the data; continued interaction with the Iowa DOT was a must.

The analysis method did take a while to compose and structure. The method of using the factors unfortunately did not present the results the researcher was seeking. Further statistical analysis on the relationship between estimating material resources and the area of bridge deck constructed would have to be performed.

The most important goal was achieved. The researcher estimated quantities of material required for the construction of the I-235. The Iowa DOT will have an idea of the scope of material that will be required to complete a project of this size. This will also inform the Iowa DOT of not only the most critical materials but also the most critical year of construction. The more informed the Iowa DOT, and hopefully the industry, the more likely it will be that the I-235 project will not be delayed by a shortage of materials and will be completed in the projected completion year of 2006.

6.2 Recommendations

The researcher has a few suggestions as how to make the process of resourcing easier. The following items can minimize the time spent on gathering and updating of resources:

- Have a concise idea what resources to track

- Understand the concept of what is entailed in resourcing material and labor
- Use the program Microsoft Excel or similar spreadsheet software to record data
- Create tables for each resource
- The tables should be created in such a way that if a change occurs it will be easy to correct
- Make clear assumptions when performing calculations

6.3 Implementation

There are a considerable number of items that one must consider when estimating quantities. Should one want to reproduce the methods used by this researcher on a project of similar scope for another agency, these are the steps as performed by this researcher.

1. Collaborated with the Iowa DOT staff
   a. Attended pre-construction, construction, and general meetings
   b. Directed questions to the staff to inquire what resources they deemed critical on this project
   c. Contacted the persons in charge of the design of I-235, in this instance, Iowa DOT design office
   d. Talked with the materials office to gather mix designs considered for construction
   e. Collaborated with the construction engineer on material, mix designs, and inspector resourcing
2. The researcher first performed a background review on resourcing projects

a. In particular looked at materials most critical to construction as noted by Iowa DOT personnel

b. Checked material producers located in the area

c. Checked production of the agencies

3. Applied the method of quantity takeoff

a. The design office, by the researcher's request, provided the staging maps of the entire I-235 reconstruction.

b. The design office also had the selected typical cross-sections for the construction of mainline.

4. Updated Quantities

a. Acquired appropriate plans with design changes

b. Updated tables with appropriate mix designs

5. Relayed information the Iowa DOT

a. Provide final quantities

b. Inform of changes

c. Encourage feedback

d. Review quantities and estimated other materials that might become critical as construction on project continues

The method of quantity takeoff, according to the researcher, seemed sufficiently accurate as well as less time consuming when proper design plans were provided. An important thing to note is that such an approach is not always possible. This approach can only be used when preliminary or final designs are completed. In order for the researcher to provide the Iowa

DOT with quantities of material demanded during the 4-year construction, the researcher's calculated factor was used as a preliminary quantity takeoff. As the design plans were completed, the researcher updated the quantities to reflect the construction demand. The factors method may not be the most accurate but it gives one an idea of the scope of material that will be required for construction and inform the Iowa DOT of the amount of material to expect as construction progresses in the next 4 years.

APPENDIX A: Conceptual Resource Estimate for Bridges

CONTINUOUS WELDED GIRDER BRIDGES

Project Number : 77-0353-116
IM-35-3(121) 85-13-77
Steel Girder; I-35 (Westbound I-80) over 2nd Ave. at the North edge of the City of Des Moines (Letting: Jan. 6, 2000)

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	326.30	0.23
2404-100100	Reinforcing Steel	kg	10,740.00	7.57
2404-100200	Reinforcing Steel, Epoxy Coated	kg	58,671.00	41.36
2408-100000	Structural Steel	kg	152,163.00	107.26
	Dual: 77.1 m x 18.4 m Continuous Welded Girder Bridge			
	Area of Bridge	1,418.64	m^2	

Project Number : 77-0353-071
IM-35-3(102) 81-13-77
Polk County; Bridge Widening; On Merle Hay Road over Beaver Creek, just North of the I-35/I-80/Merle Hay Road Interchange

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	773.40	0.29
2404-100100	Reinforcing Steel	kg	20,442.00	7.64
2404-100200	Reinforcing Steel, Epoxy Coated	kg	86,400.00	32.30
2408-100000	Structural Steel	kg	174,600.00	65.27
	Continuous I-Beam to a 64m x 41.8m Continuous Welded Girder Bridge			
	Area of Bridge	2,675.20	m^2	

Project Number : 77-0353-071
IM-35-3(105) 81-13-77
Over Merle Hay Road, at the I-35/I-80/Merle Hay Road Interchange (Letting: Mar. 24, 1998)

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	547.70	0.37
2404-100100	Reinforcing Steel	kg	31,712.00	21.54
2404-100200	Reinforcing Steel, Epoxy Coated	kg	106,063.00	72.05
2408-100000	Structural Steel	kg	326,400.00	221.74
	Dual: 80.0m x 18.4m (40.0m Span) Continuous Welded Girder Bridge			
	Dimension of bridge	1,472.00	m^2	

PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGE

Project Number : 38-5205-055
NHS-520-5(55)-19-38
Grundy County; Bridge - New; U.S. 20 (Relocated) on Vista Avenue, over U.S. 20 just east of dike; (Letting: Dec. 1, 1998)

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	228.80	0.46
2404-100100	Reinforcing Steel	kg	5,908.00	11.89
2404-100200	Reinforcing Steel, Epoxy Coated	kg	28,720.00	57.81
2408-100000	Structural Steel	kg	383.00	0.77

69.0m x 7.2m
PPCB Bridge
Area of Bridge 496.80 m^2

Project Number : 38-5205-050
NHS-520-5(50)-19-38
Grundy County; Bridge - New; U.S. 20 (Relocated) over county road T69; (Letting: Dec.

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	608.90	1.04
2404-100100	Reinforcing Steel	kg	16,462.00	28.00
2404-100200	Reinforcing Steel, Epoxy Coated	kg	72,300.00	122.96
2408-100000	Structural Steel	kg	595.00	1.01

49.0m x 12m
PPCB Bridge
Area of Bridge 588.00 m^2

Project Number : 77-0353-116
IM-35-3 (122) 86-13-77 (Bridge No. 3499)
Polk County; Bridge Replacement - PPCB; I-35 (I-80) Over NE 3rd St., east of 2nd Ave. at the North edge of the City of Des Moines; (Letting: Jan. 6, 2000)

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	187.20	0.28
2404-100100	Reinforcing Steel	kg	2,330.00	3.48
2404-100200	Reinforcing Steel, Epoxy Coated	kg	21,442.00	32.01

Dual: 36.4 m x 18.4 m
PPCB Bridge
Area of Bridge 669.76 m^2

Project Number : 77-0353-116

IM-35-3 (122) 86-13-77 (Bridge No. 3599)

Polk County; Bridge Replacement - PPCB; I-35 (I-80) Over NE 3rd St., east of 2nd Ave. at the North edge of the City of Des Moines; (Letting:

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	187.20	0.28
2404-100100	Reinforcing Steel	kg	2,330.00	3.48
2404-100200	Reinforcing Steel, Epoxy Coated	kg	21,442.00	32.01

Dual: 36.4 m x 18.4 m
PPCB Bridge
Area of Bridge 669.76 m^2

Project Number : 77-0353-116

IM-35-3 (125) 86-13-77 (Bridge No. 3799)

Polk County; Bridge Replacement - PPCB; I-35 (Westbound I-80) (Westbound off ramp) Over NE 3rd St. at the 2nd Ave. interchange; (Letting:

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	135.10	0.47
2404-100100	Reinforcing Steel	kg	2,192.00	7.70
2404-100200	Reinforcing Steel, Epoxy Coated	kg	15,785.00	55.44

36.5 m x 7.8 m
PPCB Bridge
Area of Bridge 284.70 m^2

Project Number : 77-0353-116

IM-35-3 (129) 86-13-77 (Bridge No. 4599)

Polk County; Bridge New - PPCB; I-35 (Westbound I-80) Over Union Pacific RR at the east14th street interchange; (Letting: Jan. 6,

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	211.20	0.48
2404-100100	Reinforcing Steel	kg	21,761.00	49.38
2404-100200	Reinforcing Steel, Epoxy Coated	kg	26,508.00	60.15
2408-100000	Structural Steel	kg	1,213.80	2.75

56.5 m x 7.8 m
PPCB Bridge
Area of Bridge 440.70 m^2

Project Number : 77-0353-116
IM-35-3 (130) 86-13-77 (Bridge No. 4299)
Polk County; Bridge Replacement - PPCB; I-35 Over Union Pacific RR, 0.3 km east of E. 14th St.; (Letting: Jan. 6, 2000)

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	363.90	0.16
2404-100100	Reinforcing Steel	kg	28,069.00	12.45
2404-100200	Reinforcing Steel, Epoxy Coated	kg	33,327.00	14.78
2408-100000	Structural Steel	kg	2,340.60	1.04
	Dual: 59.5 m x18.4m and 59.5 m x 19.5m PPCB Bridge			
	Area of Bridge	2,255.05 m^2		

Project Number : 77-0353-116
IM-35-3 (130) 86-13-77 (Bridge No. 4399)
Polk County; Bridge Replacement; I-35 (I-80) Over Union Pacific RR, 0.3 km east of the E. 4th St.(Letting: Jan. 6, 2000)

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	332.30	0.15
2404-100100	Reinforcing Steel	kg	27,390.00	12.15
2404-100200	Reinforcing Steel, Epoxy Coated	kg	35,689.00	15.83
2408-100000	Structural Steel	kg	2,172.60	0.96
	Dual: 59.5 m x18.4m and 59.5 m x 19.5m PPCB Bridge			
	Area of Bridge	2,255.05 m^2		

Project Number : 77-0353-116
IM-35-3 (132) 86-13-77 (Bridge No. 4799)
Polk County; Bridge Replacement - PPCB; I-35 (I-80) Over Union Pacific RR (two tracks), 1.0 km east of E. 14th St.; (Letting: Jan. 6, 2000)

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	613.00	0.34
2404-100100	Reinforcing Steel	kg	55,512.00	30.53
2404-100200	Reinforcing Steel, Epoxy Coated	kg	47,771.00	26.28
2408-100000	Structural Steel	kg	3,873.80	2.13
	Dual: 90.0 m x 20.2 PPCB Bridge			
	Area of Bridge	1,818.00 m^2		

Project Number : 77-0353-116

IM-35-3 (132) 86-13-77 (Bridge No. 4899)

Polk County; Bridge Replacement - PPCB; I-35 (I-80) Over Union Pacific RR (two tracks), 1.0 km east of E. 14th St.; (Letting: Jan. 6, 2000)

Item :	Description	Unit	Quantity	Quantity per m^2
2403-100010	Structural Concrete (Bridge)	m^3	613.00	0.34
2404-100100	Reinforcing Steel	kg	55,512.00	30.53
2404-100200	Reinforcing Steel, Epoxy Coated	kg	57,187.00	31.46
2408-100000	Structural Steel	kg	3,873.80	2.13
	Dual: 90.0 m x 20.2			
	PPCB Bridge			
	Area of Bridge	1,818.00 m^2		

Quantity of Material based on quantity factors of previous projects

CONTINUOUS WELDED GIRDER BRIDGES

Sta 514+23.02 (I-235)
Sta 16014+23.02 (Cottage Grove)
116.5m x 12.6m Roadway with 1.8m sidewalk and 4.2m Bike Trail Continuous Welded Girder Bridge
Spans: (52.50m, 62.00m)

Item :	Description	Unit	per m^2 Low	per m^2 High	per m^2 Average	Quantity Low	Quantity High	Quantity Average
2403-100010	Structural Concrete (Bridge)	m^3	0.23	0.37	0.30	337.62	546.06	435.97
2404-100100	Reinforcing Steel	kg	7.57	21.54	12.25	11,113.47	31,622.97	17,984.71
2404-100200	Reinforcing Steel, Epoxy Coated	kg	32.30	72.05	48.57	47,408.77	105,768.07	71,294.44
2408-100000	Structural Steel	kg	65.27	221.74	131.42	95,803.96	325,490.68	192,911.42

Area of Bridge 1,467.90 m^2

Sta 545+68.436 (I-235)
Sta 26045+68.436 (East 6th St.)
87.7m x 12.6m Continuous Welded Steel Girder Bridge with 2.4m sidewalk
Spans: (45.1m, 42.6m)

Item :	Description	Unit	per m^2 Low	per m^2 High	per m^2 Average	Quantity Low	Quantity High	Quantity Average
2403-100010	Structural Concrete (Bridge)	m^3	0.23	0.37	0.30	254.15	411.07	328.19
2404-100100	Reinforcing Steel	kg	7.57	21.54	12.25	8,366.11	23,805.45	13,538.71
2404-100200	Reinforcing Steel, Epoxy Coated	kg	32.30	72.05	48.57	35,688.83	79,621.11	53,669.72
2408-100000	Structural Steel	kg	65.27	221.74	131.42	72,120.24	245,026.03	145,221.73

Area of Bridge 1,105.02 m^2

Sta 29048+92.898 (East 9th St.)
130.0m x 9.0m Continuous Welded Girder Bridge with (2) 2.4m sidewalks
Spans: (21.5m, 30.5m end; 39.0m, 39.0m int.)

Item :	Description	Unit	per m^2 Low	per m^2 High	per m^2 Average	Quantity Low	Quantity High	Quantity Average
2403-100010	Structural Concrete (Bridge)	m^3	0.23	0.37	0.30	269.10	435.24	347.49
2404-100100	Reinforcing Steel	kg	7.57	21.54	12.25	8,858.07	25,205.31	14,334.84
2404-100200	Reinforcing Steel, Epoxy Coated	kg	32.30	72.05	48.57	37,787.49	84,303.18	56,825.73
2408-100000	Structural Steel	kg	65.27	221.74	131.42	76,361.22	259,434.63	153,761.40

Area of Bridge 1,170.00 m^2

Sta 33170+61.205 (University Ave. Ramp)
92.1m x 7.8m Continuous Welded Curved Girder Bridge
Spans: (18.6m, 33.05m, 24.57m, 15.88m)

Item :	Description	Unit	per m² Low	per m² High	per m² Average	Quantity Low	Quantity High	Quantity Average
2403-100010	Structural Concrete (Bridge)	m^3	0.23	0.37	0.30	165.23	267.24	213.36
2404-100100	Reinforcing Steel	kg	7.57	21.54	12.25	5,438.85	15,476.06	8,801.59
2404-100200	Reinforcing Steel, Epoxy Coated	kg	32.30	72.05	48.57	23,201.52	51,762.15	34,891.00
2408-100000	Structural Steel	kg	65.27	221.74	131.42	46,885.79	159,292.86	94,409.50

Area of Bridge 718.38 m^2

Sta 574+06.853 (Easton Rd.)
52.4m x 18.0m Simple Span Welded Girder Bridge
Spans: (53.6m)

Item :	Description	Unit	per m² Low	per m² High	per m² Average	Quantity Low	Quantity High	Quantity Average
2403-100010	Structural Concrete (Bridge)	m^3	0.23	0.37	0.30	216.94	350.87	280.13
2404-100100	Reinforcing Steel	kg	7.57	21.54	12.25	7,140.97	20,319.36	11,556.09
2404-100200	Reinforcing Steel, Epoxy Coated	kg	32.30	72.05	48.57	30,462.53	67,961.33	45,810.28
2408-100000	Structural Steel	kg	65.27	221.74	131.42	61,558.89	209,144.22	123,955.34

Area of Bridge 943.20 m^2

Quantity of Material based on quantity factors of previous projects

PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGE

Sta 2418+41.711 (42nd St.)
Sta 418+41.711 (I-235)
76.8m x 9.0m Pretensioned Prestressed Concrete Beam Bridge with 1.8m sidewalk
Spans: (38.4m, 38.4m)

Item :	Description	Unit	per m^2 Low	per m^2 High	per m^2 Average	Quantity Low	Quantity High	Quantity Average
2403-100010	Structural Concrete (Bridge)	m^3	0.15	1.04	0.40	101.61	716.08	275.79
2404-100100	Reinforcing Steel	kg	3.48	49.38	18.96	2,404.68	34,130.07	13,104.46
2404-100200	Reinforcing Steel, Epoxy Coated	kg	14.78	122.96	45.40	10,215.24	84,989.26	31,380.48
2408-100000	Structural Steel	kg	1.01	383.00	56.15	699.49	264,729.60	38,808.81

Area of Bridge 691.20 m^2

Sta 4434+53.517 (28th St.)
Sta 434+53.520 (I-235)
82.9m x 9.0m Pretensioned Prestressed Concrete Beam Bridge with 1.8m sidewalk
Spans: (41.45m, 41.50m)

Item :	Description	Unit	per m^2 Low	per m^2 High	per m^2 Average	Quantity Low	Quantity High	Quantity Average
2403-100010	Structural Concrete (Bridge)	m^3	0.15	1.04	0.40	109.68	772.96	297.69
2404-100100	Reinforcing Steel	kg	3.48	49.38	18.96	2,595.68	36,840.93	14,145.31
2404-100200	Reinforcing Steel, Epoxy Coated	kg	14.78	122.96	45.40	11,026.61	91,739.71	33,872.94
2408-100000	Structural Steel	kg	1.01	383.00	56.15	755.05	285,756.30	41,891.28

Area of Bridge 746.10 m^2

Comparison of Quantity of Actual Material as proposed in the proposal and as calculated with factors

CONTINUOUS WELDED GIRDER BRIDGES

Sta 514+23.02 (I-235)
Sta 16014+23.02 (Cottage Grove)
116.5m x 12.6m Roadway with 1.8m sidewalk and 4.2m Bike Trail Continuous Welded Girder Bridge
Spans: (52.50m, 62.00m)

Item :	Description	Unit	Quantity (in Proposal)	Quantity from Factors: Quantity Low	Quantity High	Quantity Average	Comparison of Proposal to Factor Quantity
2403-100010	Structural Concrete (Bridge)	m^3	178.50	337.62	546.06	435.97	Below Low
2404-100100	Reinforcing Steel	kg	29,720.00	11,113.47	31,622.97	17,984.71	Between Average and High
2404-100200	Reinforcing Steel, Epoxy Coated	kg	171,076.00	47,408.77	105,768.07	71,294.44	Above High
2408-100000	Structural Steel	kg	559,000.00	95,803.96	325,490.68	192,911.42	Above High

Area of Bridge 1,467.90 m^2

Sta 545+68.436 (I-235)
Sta 26045+68.436 (East 6th St.)
87.7m x 12.6m Continuous Welded Steel Girder Bridge with 2.4m sidewalk
Spans: (45.1m, 42.6m)

Item :	Description	Unit	Quantity (in Proposal)	Quantity from Factors: Quantity Low	Quantity High	Quantity Average	Comparison of Proposal to Factor Quantity
2403-100010	Structural Concrete (Bridge)	m^3	125.00	254.15	411.07	328.19	Below Low
2404-100100	Reinforcing Steel	kg	17,498.00	8,366.11	23,805.45	13,538.71	Between Average and High
2404-100200	Reinforcing Steel, Epoxy Coated	kg	88,106.00	35,688.83	79,621.11	53,669.72	Above High
2408-100000	Structural Steel	kg	237,755.00	72,120.24	245,026.03	145,221.73	Between Average and High

Area of Bridge 1,105.02 m^2

Sta 29048+92.898 (East 9th St.)
130.0m x 9.0m Continuous Welded Girder Bridge with (2) 2.4m sidewalks
Spans: (21.5m, 30.5m end; 39.0m, 39.0m int.)

Item :	Description	Unit	Quantity (in Proposal)	Quantity from Factors: Quantity Low	Quantity High	Quantity Average	Comparison of Proposal to Factor Quantity
2403-100010	Structural Concrete (Bridge)	m^3	426.70	269.10	435.24	347.49	Between Average and High
2404-100100	Reinforcing Steel	kg	47,219.00	8,858.07	25,205.31	14,334.84	Above High
2404-100200	Reinforcing Steel, Epoxy Coated	kg	112,646.00	37,787.49	84,303.18	56,825.73	Above High
2408-100000	Structural Steel	kg	275,000.00	76,361.22	259,434.63	153,761.40	Above High

Area of Bridge 1,170.00 m^2

Sta 33170+61.205 (University Ave. Ramp)
92.1m x 7.8m Continuous Welded Curved Girder Bridge
Spans: (18.6m, 33.05m, 24.57m, 15.88m)

Item :	Description	Unit	Quantity (in Proposal)	Quantity from Factors			Comparison of Proposal to Factor Quantity
				Quantity Low	Quantity High	Quantity Average	
2403-100010	Structural Concrete (Bridge)	m^3	135.70	269.10	435.24	347.49	Below Low
2404-100100	Reinforcing Steel	kg	47,422.00	8,858.07	25,205.31	14,334.84	Above High
2404-100200	Reinforcing Steel, Epoxy Coated	kg	46,685.00	37,787.49	84,303.18	56,825.73	Between Low and Average
2408-100000	Structural Steel	kg	117,963.00	76,361.22	259,434.63	153,761.40	Between Low and Average

Area of Bridge 718.38 m^2

Sta 574+06.853 (Easton Rd.)
52.4m x 18.0m Simple Span Welded Girder Bridge
Spans: (53.6m)

Item :	Description	Unit	Quantity (in Proposal)	Quantity from Factors			Comparison of Proposal to Factor Quantity
				Quantity Low	Quantity High	Quantity Average	
2403-100010	Structural Concrete (Bridge)	m^3	74.60	216.94	350.87	280.13	Below Low
2404-100100	Reinforcing Steel	kg	5,895.00	7,140.97	20,319.36	11,556.09	Below Low
2404-100200	Reinforcing Steel, Epoxy Coated	kg	64,312.00	30,462.53	67,961.33	45,810.28	Between Average and High
2408-100000	Structural Steel	kg	292,712.00	61,558.89	209,144.22	123,955.34	Above High

Area of Bridge 943.20 m^2

Comparison of Quantity of Actual Material as proposed in the proposal and as calculated with factors

PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGES

Sta 2418+41.711 (42nd St.)
Sta 418+41.711 (I-235)
76.8m x 9.0m Pretensioned Prestressed Concrete Beam Bridge with 1.8m sidewalk
Spans: (38.4m, 38.4m)

Item :	Description	Unit	Quantity (in Proposal)	Quantity from Factors Quantity Low	Quantity High	Quantity Average	Comparison of Proposal to Factor Quantity
2403-100010	Structural Concrete (Bridge	m^3	32.80	101.61	716.08	275.79	Below Low
2404-100100	Reinforcing Steel	kg	10,747.00	2,404.68	34,130.07	13,104.46	Between Low and Average
2404-100200	Reinforcing Steel, Epoxy Coated	kg	59,920.00	10,215.24	84,989.26	31,380.48	Between Average and
2408-100000	Structural Steel	kg	7,337.00	699.49	264,729.60	38,808.81	Between Low and Average

Area of Bridge 691.20 m^2

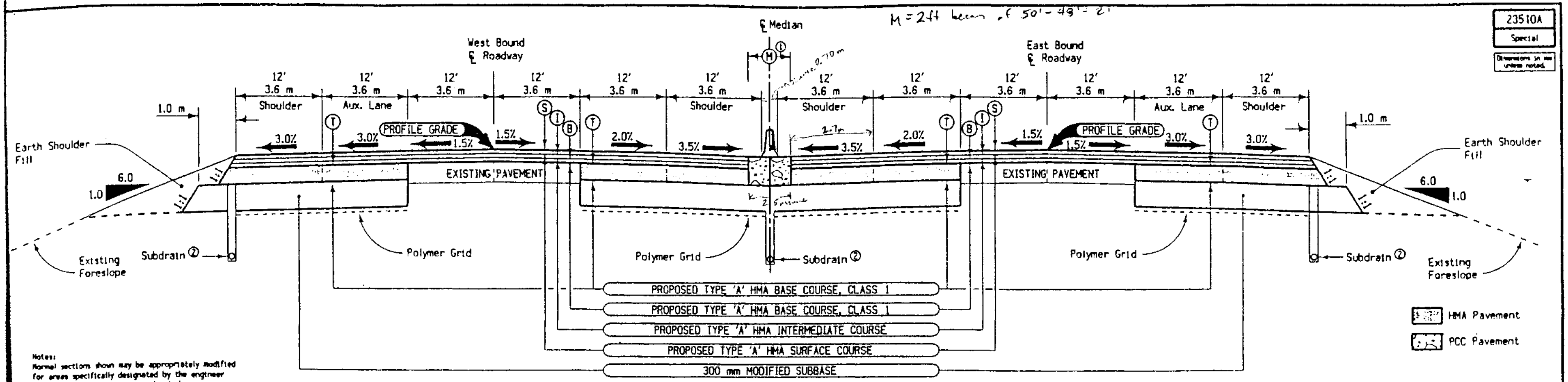
Sta 4434+53.517 (28th St.)
Sta 434+53.520 (I-235)
82.9m x 9.0m Pretensioned Prestressed Concrete Beam Bridge with 1.8m sidewalk
Spans: (41.45m, 41.50m)

Item :	Description	Unit	Quantity (in Proposal)	Quantity from Factors Quantity Low	Quantity High	Quantity Average	Comparison of Proposal to Factor Quantity
2403-100010	Structural Concrete (Bridge	m^3	33.20	109.68	772.96	297.69	Below Low
2404-100100	Reinforcing Steel	kg	10,895.00	2,595.68	36,840.93	14,145.31	Between Low and Average
2404-100200	Reinforcing Steel, Epoxy Coated	kg	64,806.00	11,026.61	91,739.71	33,872.94	Between Average and
2408-100000	Structural Steel	kg	7,394.00	755.05	285,756.30	41,891.28	Between Low and Average

Area of Bridge 746.10 m^2

APPENDIX B: Conceptual Quantity Takeoff of Concrete/Asphalt/Fence

23510A
Special



Notes:
Normal sections shown may be appropriately modified for areas specifically designated by the engineer such as intersections or superelevated curves.

Refer to other drawings for details of shoulder design and construction.

① Refer to Typical MED-1, MED-2, MED-3, or MED-4 for details of P.C.C. median with barrier rail.

② Refer to Standard Road Plan RF-19C for details of subdrain installation.

LOCATION			(T)	(B)	(I)	(S)	(M)
ROAD IDENTIFICATION	STATION TO STATION		mm	mm	mm	mm	m
	409 + 00	432 + 40	180 7"	80 3"	65 2.5"	65 2.5"	
	598 + 00	615 + 00	180 7"	80 3"	65 2.5"	65 2.5"	

TYPICAL CROSS SECTION #1
4-LANE UNDIVIDED ROADWAY
15.24 MEDIAN (50')

62

RESURFACE:

STA.	(LENGTH)	AREA
409+00 → 432+40	2340 M	33,696 M²
598+00 → 615+00	1700 M	24,480 M²

DESIGN TEAM Schoenrock/Mackey/Maach	METRIC	IOWA DOT • OFFICE OF DESIGN	POLK COUNTY	PROJECT NUMBER	TYPICAL SECTION 1	SHEET NUMBER 1

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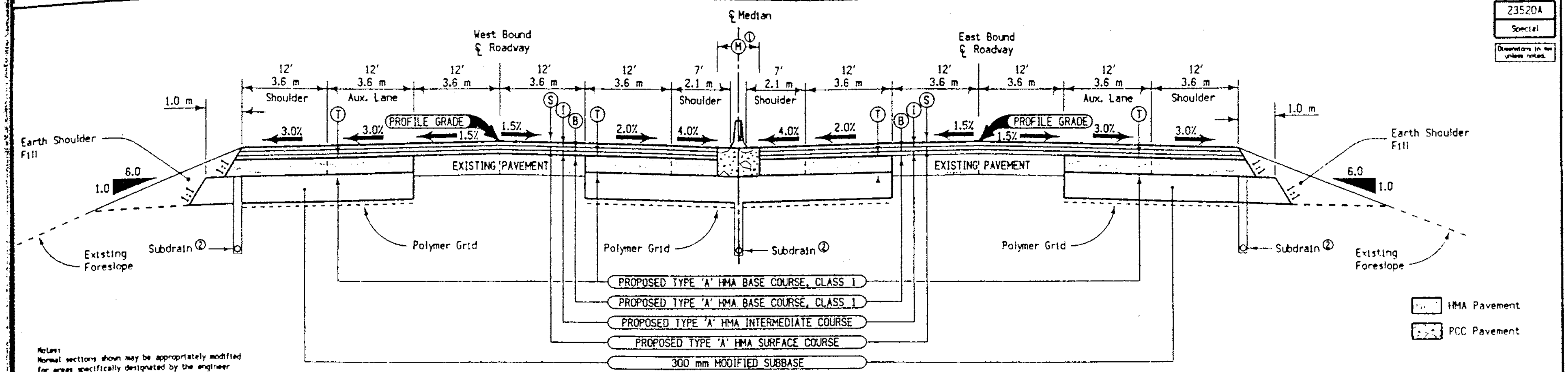


Notes:
Normal sections shown may be appropriately modified for areas specifically designated by the engineer such as intersections or superelevated curves.

Refer to other drawings for details of shoulder design and construction.

① Refer to Typical MED-1, MED-2, MED-3, or MED-4 for details of P.C.C. median with barrier rail.

② Refer to Standard Road Plan RF-19C for details of subdrain installation.

LOCATION			Ⓣ	Ⓑ	Ⓘ	Ⓢ	Ⓜ
ROAD IDENTIFICATION	STATION TO STATION		mm	mm	mm	mm	m
	432 + 40	450 + 60	180	80	65	65	
			7"	3"	2.5"	2.5"	
	470 + 55	502 + 20	180	80	65	65	
			7"	3"	2.5"	2.5"	

TYPICAL CROSS SECTION #2
4-LANE UNDIVIDED ROADWAY
12.20 MEDIAN (40')

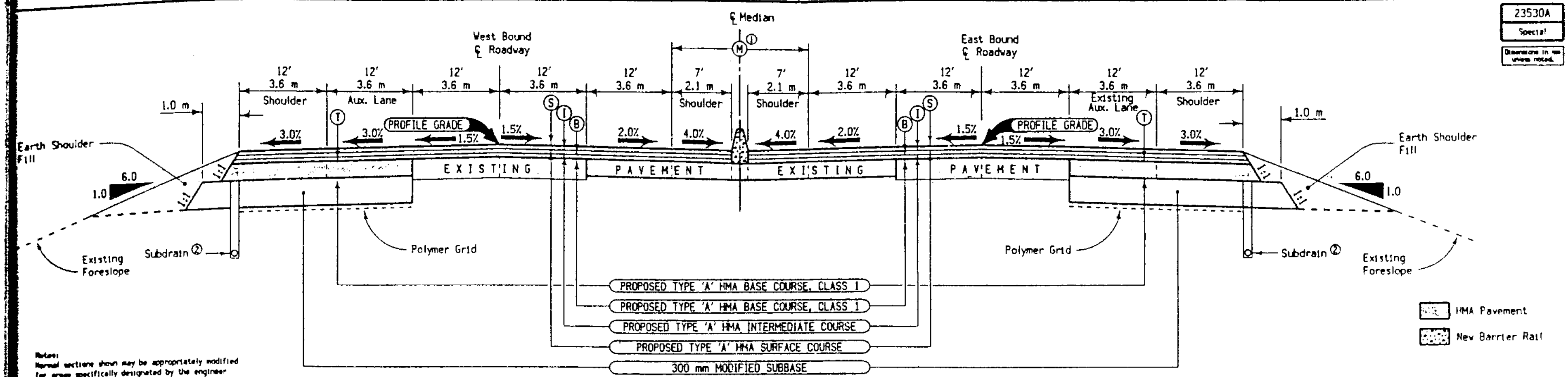
63

RESURFACE:

STA.	(LENGTH)	AREA
432+40 → 450+60	1705 M*	24,552 M²
470+55 → 502+20	3120 M**	44,928 M²

* GAP FOR 22ND ST. (WD's M) BRIDGE = 65 M
17TH ST. (WD's M) BRIDGE = 50 M

** GAP FOR 35TH ST. BRIDGE = 45 M



Notes:
Normal sections shown may be appropriately modified for areas specifically designated by the engineer such as intersections or superelevated curves.

Refer to other drawings for details of shoulder design and construction.

① Refer to Typical MED-1, MED-2, MED-3, or MED-4 for details of P.C.C. median with barrier rail.

② Refer to Standard Road Plan RF-19C for details of subdrain installation.

LOCATION			(T)	(B)	(I)	(S)	(M)
ROAD IDENTIFICATION	STATION TO STATION		mm	mm	mm	mm	m
	450 + 60	470 + 55	180 7"	80 3"	65 2.5"	65 2.5"	

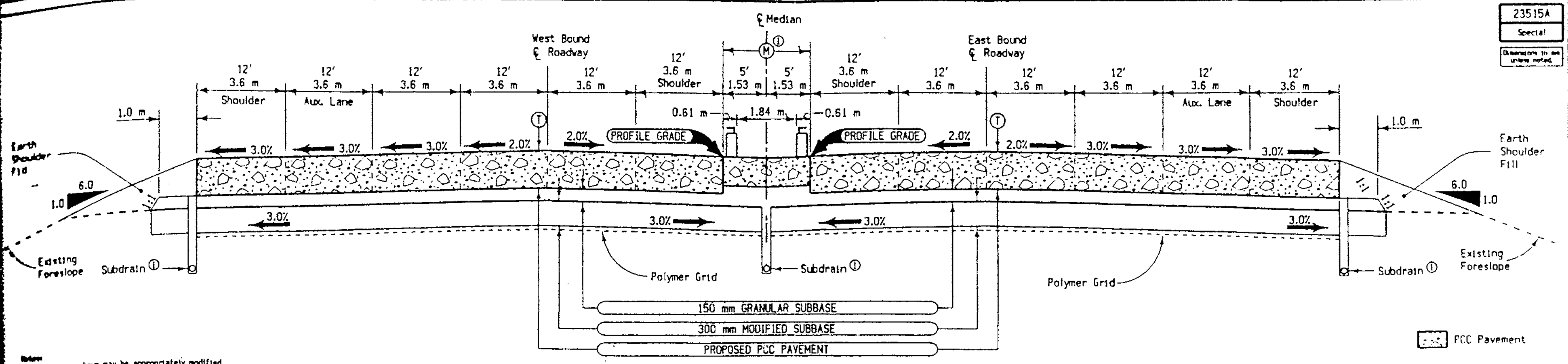
TYPICAL CROSS SECTION #3
4-LANE UNDIVIDED ROADWAY
12.20 MEDIAN (40')

64

RESURFACE:

STA.	(LENGTH)	AREA
450+60 → 470+55	1720 M*	52,286 M²

* GAP FOR 73RD ST. BRIDGE = 100 M
WALNUT CK = 100 M
CUMMINS PK BRIDGE = 75 M



Notes:
Typical sections shown may be appropriately modified for areas specifically designated by the engineer such as intersections or superelevated curves.

Refer to other drawings for details of shoulder design and construction.

① Refer to Standard Road Plan RF-19C for details of subdrain installation.

LOCATION			(M)	(T)
ROAD IDENTIFICATION	STATION TO STATION		m	mm
	502 + 20	598 + 00		300
				12"

(FULL RECONSTRUCTION)

TYPICAL CROSS SECTION #4
4-LANE UNDIVIDED ROADWAY
RECONSTRUCTION

65

DESIGN TEAM Schoenrock/Mackey/Maach	METRIC	IOWA DOT • OFFICE OF DESIGN		POLK COUNTY	PROJECT NUMBER TYPICAL SECTION 4	SHEET NUMBER 4

Section 1-3 (Material Quantity) Mainline

12inches = 0.31 m (Granular base)
12inches = 0.31 m (PCC thickness)
9 inches = 0.23 m (ACC layer)
8 inches = 0.21 m (ACC overlay)

Typical 1 (Cross section)
The length of section 1-3 with Typical 1 is 2300m.

PCC in the center (beneath the barrier wall)
1.6m x 0.23m x 2300m = **847 m^3**

ACC (median and inside lane) (EB & WB)
2 x 6.8m x 0.23m x 2300m = **7195 m^3**

ACC (shoulder and auxiliary lane) (EB & WB)
14.63m x 0.23m x 2300m = **7740 m^3**

GRANULAR BASE
1) Beneath the shoulder and auxiliary lane:
16.71m x 0.31m x 2300m = **11915 m^3**

2) Beneath the barrier wall, median and inner lane:
15.2m x 0.31m x 2300m = **10838 m^3**

ACC overlay (entire 2300 m of roadway EB &WB)
2 x 21.6m x 0.21m x 2300m = **20866 m^3**

Totals for Typical 1: **Granular Base----22753 m^3**
PCC-------------- 847 m^3
ACC------------- 35801 m^3

Typical 2 (Cross section)
The length of section 1-3 with Typical 2 is 1870m.

PCC in the center (beneath the barrier wall)
1.6m x 0.23m x 1870m = **689 m^3**

ACC (median and inside lane) (EB & WB)
2 x 5.3m x 0.23m x 1870m = **4560 m^3**

ACC (shoulder and auxiliary lane) (EB & WB)
14.63m x 0.23m x 1870m = **6293 m^3**

GRANULAR BASE

1) Beneath the shoulder and auxiliary lane:
16.71m x 0.31m x 1870m = **9687 m^3**

2) Beneath the barrier wall, median and inner lane:
13m x 0.31m x 1870m = **7537 m^3**

ACC overlay (entire 1870 m of roadway EB &WB)
2 x 20.1m x 0.21m x 1870m = **15787 m^3**

Totals for Typical 2: **Granular Base----17224 m^3**
PCC-------------- 689 m^3
ACC-------------- 26640 m^3

<u>Typical 3 (Cross section)</u>
The length of section 1-3 with Typical 3 is 680m.

ACC (WB shoulder and auxiliary lane)
7.2m x 0.23m x 680m + 0.5 x 0.31m x 0.31m x 680m = **1159 m^3**

ACC (EB shoulder)
3.6m x 0.23m x 680m + 0.5 x 0.23m x 0.23m x 680m = **582 m^3**

ACC overlay (EB & WB)
2 x 20.1m x 0.21m x 680m = **5741 m^3**

GRANULAR BASE

1) Beneath the shoulder and auxiliary lane (WB):
8.2m x 0.31m x 680m + 0.5 x 0.31m x 0.31m x 680m = **1762 m^3**

2) Beneath the shoulder lane (EB):
4.6m x 0.31m x 680m + 0.5 x 0.31m x 0.31m x 680m = **1003 m^3**

Totals for Typical 3: **Granular Base----2765 m^3**
ACC-------------- 7482 m^3

Section 1 – 3 (Total for Typical 1, 2, and 3)

Granular Base----42742 m^3
PCC--------------- 1536 m^3
ACC-------------- 69923 m^3

Section 4 (Material Quantity) Mainline

Typical 3 (Cross section)
The length of section 4 with Typical 3 is 1080m.

ACC (WB shoulder and auxiliary lane)
7.2m x 0.23m x 1080m + 0.5 x 0.31m x 0.31m x 1080m = **1841 m^3**

ACC (EB shoulder)
3.6m x 0.23m x 1080m + 0.5 x 0.23m x 0.23m x 1080m = **947 m^3**

ACC overlay (EB & WB)
2 x 20.1m x 0.21m x 1080m = **9118 m^3**

GRANULAR BASE
1) Beneath the shoulder and auxiliary lane (WB):
8.2m x 0.31m x 1080m + 0.5 x 0.31m x 0.31m x 1080m = **2798 m^3**

2) Beneath the shoulder lane (EB):
4.6m x 0.31m x 1080m + 0.5 x 0.31m x 0.31m x 1080m = **1592 m^3**

Totals for Typical 3: **Granular Base----4390 m^3**
ACC------------- 11906 m^3

Typical 2 (Cross section)
The length of section 4 with Typical 2 is 3660m.

PCC in the center (beneath the barrier wall)
1.6m x 0.23m x 3660m = **1347 m^3**

ACC (median and inside lane) (EB & WB)
2 x 5.3m x 0.23m x 3660m = **8924 m^3**

ACC (shoulder and auxiliary lane) (EB & WB)
14.63m x 0.23m x 3660m = **12316 m^3**

GRANULAR BASE

1) Beneath the shoulder and auxiliary lane:
16.71m x 0.31m x 3660m = **18960 m^3**

2) Beneath the barrier wall, median and inner lane:
13m x 0.31m x 3660m = **14750 m^3**

ACC overlay (entire 3660 m of roadway EB &WB)
2 x 20.1m x 0.21m x 3660m = **30898 m^3**

Totals for Typical 2: **Granular Base----33710 m^3**
PCC-------------- 1347 m^3
ACC------------- 52138 m^3

Section 4 (Total for Typical 2 and 3)

Granular Base----38100 m^3
PCC-------------- 1347 m^3
ACC------------- 64044 m^3

Section 5 (Material Quantity) Mainline

Typical 4 (Cross section)
The length of section 5 with Typical 4 is 2910m.

PCC (EB & WB entire roadway)
2 x 0.31m x 19.53m x 2910m = **35237 m^3**

GRANULAR BASE (EB & WB entire roadway)
2 x 0.31m x 24.31m x 2910m = **43861 m^3**

Totals for Typical 4: **Granular Base----43861 m^3**
PCC------------- 35237 m^3

Section 5 (Total for Typical 4)

Granular Base----43861 m^3
PCC-------------- 35237 m^3

Section 6 (Material Quantity) Mainline

Typical 4 (Cross section)
The length of section 6 with Typical 4 is 2550m.

PCC (EB & WB entire roadway)
2 x 0.31m x 19.53m x 2550m = **30877 m^3**

GRANULAR BASE (EB & WB entire roadway)
2 x 0.31m x 24.31m x 2550m = **38435 m^3**

Totals for Typical 4: **Granular Base----38435 m^3**
PCC------------- 30877 m^3

Section 6 (Total for Typical 4)

Granular Base----38435 m^3
PCC-------------- 30877 m^3

Section 7 (Material Quantity) Mainline

Typical 4 (Cross section)
The length of section 7 with Typical 4 is 1540m.

PCC (EB & WB entire roadway)
2 x 0.31m x 19.53m x 1540m = **18648 m^3**

GRANULAR BASE (EB & WB entire roadway)
2 x 0.31m x 24.31m x 1540m = **23212 m^3**

Totals for Typical 4: **Granular Base----23212 m^3**
PCC------------- 18648 m^3

Section 7 (Total for Typical 4)

Granular Base----23212 m^3
PCC-------------- 18648 m^3

Section 8-10 (Material Quantity) Mainline

Typical 4 (Cross section)
The length of section 8-10 with Typical 4 is 800m.

PCC (EB & WB entire roadway)
2 x 0.31m x 19.53m x 800m = **9687 m^3**

GRANULAR BASE (EB & WB entire roadway)
2 x 0.31m x 24.31m x 800m = **12058 m^3**

Totals for Typical 4: **Granular Base----12058 m^3**
PCC------------- 9687 m^3

Typical 1 (Cross section)
The length of section 8-10 with Typical 1 is 2525m.

PCC in the center (beneath the barrier wall)
1.6m x 0.23m x 2525m = **930 m^3**

ACC (median and inside lane) (EB & WB)
2 x 6.8m x 0.23m x 2525m = **7899 m^3**

ACC (shoulder and auxiliary lane) (EB & WB)
14.63m x 0.23m x 2525m = **8497 m^3**

GRANULAR BASE
1) Beneath the shoulder and auxiliary lane:
16.71m x 0.31m x 2525m = **13080 m^3**

2) Beneath the barrier wall, median and inner lane:
15.2m x 0.31m x 2525m = **11898 m^3**

ACC overlay (entire 2525 m of roadway EB &WB)
2 x 21.6m x 0.21m x 2525m = **22907 m^3**

Totals for Typical 1: **Granular Base----24978 m^3**
PCC-------------- 930 m^3
ACC------------- 39303 m^3

Section 8-10 (Total for Typical 1 and 4)

Granular Base----	**37036 m^3**
PCC--------------	**10617 m^3**
ACC-------------	**39303 m^3**

TOTAL FOR THE ENTIRE MAINLINE

Granular Base----	**223386 m^3**
PCC--------------	**98262 m^3**
ACC-------------	**173270 m^3**

Bridge Deck Resource

(Density: assume 150 lb/ft^3

Assume depth of 12in. = 0.31m

Bridge Deck (list)	Year	Location	**Area (m^2)**	**Volume (m^3)**
1	2003	Euclid Ave.	2,212.80	**686**
2	2002/2005	Easton Rd.	943.20	**292**
3	2002/2005	E. 21st St.	214.11	**66**
4	2003/2005	University Ave.	718.38	**223**
5	2003	E. 12th St.	1,255.80	**389**
6	2002	E. 9th St.	1,794.00	**556**
7	2003	Penn Ave.	1,500.00	**465**
8	2002	E. 6th St.	1,315.50	**408**
10	2004/2005/2006	Des Moines River	15,720.00	**4,873**
11	2003	2nd Ave.	1,980.00	**614**
12	2004	3rd St.	1,906.00	**591**
13	2003	5th Ave.	774.00	**240**
14	2004	6th Ave	1,467.18	**455**
15	2003	7th St.	1,161.54	**360**
16	2002	9th St.	2,068.00	**641**
17	2003	19th St.	1,362.00	**422**
18	2002	MLK	1,510.20	**468**
19	2002	Cottage Grove	2,166.90	**672**
21	2002	Polk Blvd.	627.30	**194**
22	2002	28th St. (WDSM)	895.32	**278**
24	2002	42nd St. (WDSM)	829.44	**257**

13,151 m^3
34,827 Tons
31,595 Mg

Mainline Concrete Material breakdown

The mix designs for the PCC pavement is assumed to be C-3WR (see I.M. 529).
The thickness of the PCC pavement is assumed at 0.31m (12 in.).

(Density: assume 150 lb/ft^3)
Multiply by a factor of 0.9072 to convert from Tons to Mg

Roadway Section	Fly ash or Slag (3.78%) Required (Year)					
	2002	2003	2004	2005	2006	
1-3				154		
4				121	14	
5				1,764	1,764	
6			309	1,236	1,546	
7		448	411	504	504	
8-10				1,010	53	Total
Total	**0**	**448**	**720**	**4,789**	**3,881**	**9,838** TONS

Roadway Section	Fly ash or Slag (3.78%) Required (Year)					
	2002	2003	2004	2005	2006	
1-3				140		
4				110	13	
5				1,600	1,600	
6			280	1,121	1,403	
7		406	373	457	457	
8-10				916	48	Total
Total	**0**	**406**	**653**	**4,345**	**3,521**	**8,925** Mg

Roadway Section	Cement (7.02%) Required (Year)					
	2002	2003	2004	2005	2006	
1-3				286		
4				225	25	
5				3,275	3,275	
6			574	2,297	2,870	
7		832	763	936	936	
8-10				1,875	99	Total
Total	**0**	**832**	**1,337**	**8,894**	**7,205**	**18,268** TONS

Roadway Section	Cement (7.02%) Required (Year)					
	2002	2003	2004	2005	2006	
1-3				259		
4				204	23	
5				2,971	2,971	
6			521	2,084	2,604	
7		755	692	849	849	
8-10				1,701	90	Total
Total	**0**	**755**	**1,213**	**8,069**	**6,536**	**16,573** Mg

Mainline Concrete Material breakdown (cont'd)

Roadway Section	Water (14.6%) Required (Year)						
	2002	2003	2004	2005	2006		
1-3				594			
4				469	52		
5				6,812	6,812		
6			1,195	4,775	5,969		
7		1,730	1,586	1,947	1,947		
8-10				3,900	205	Total	
Total	**0**	**1,730**	**2,781**	**18,497**	**14,985**	**37,993**	**TONS**

Roadway Section	Water (14.6%) Required (Year)						
	2002	2003	2004	2005	2006		
1-3				539			
4				425	47		
5				6,180	6,180		
6			1,084	4,332	5,415		
7		1,569	1,439	1,766	1,766		
8-10				3,538	186	Total	
Total	**0**	**1,569**	**2,523**	**16,780**	**13,594**	**34,467**	**Mg**

Roadway Section	Coarse Aggregate (37.7%) Required (Year)						
	2002	2003	2004	2005	2006		
1-3				1,534			
4				1,210	135		
5				17,591	17,591		
6			3,083	12,331	15,414		
7		4,468	4,096	5,027	5,027		
8-10				10,070	530	Total	
Total	**0**	**4,468**	**7,179**	**47,763**	**38,697**	**98,107**	**TONS**

Roadway Section	Coarse Aggregate (37.7%) Required (Year)						
	2002	2003	2004	2005	2006		
1-3				1,392			
4				1,098	122		
5				15,959	15,959		
6			2,797	11,187	13,984		
7		4,053	3,716	4,560	4,560		
8-10				9,136	481	Total	
Total	**0**	**4,053**	**6,513**	**43,331**	**35,106**	**89,003**	**Mg**

Roadway Section	Fine Aggregate (30.9%) Required (Year)						
	2002	2003	2004	2005	2006		
1-3				1,257			
4				992	110		
5				14,418	14,418		
6			2,527	10,107	12,634		
7		3,662	3,357	4,120	4,120		
8-10				8,254	434	Total	
Total	**0**	**3,662**	**5,884**	**39,148**	**31,716**	**80,410**	**TONS**

Roadway Section	Fine Aggregate (30.9%) Required (Year)						
	2002	2003	2004	2005	2006		
1-3				1,140			
4				900	100		
5				13,080	13,080		
6			2,292	9,169	11,462		
7		3,322	3,045	3,738	3,738		
8-10				7,488	394	Total	
Total	**0**	**3,322**	**5,338**	**35,515**	**28,773**	**72,948**	**Mg**

Mainline Asphalt Material breakdown

(Density: assume 150 lb/ft^3)
Multiply by a factor of 0.9072 to convert from Tons to Mg

Roadway Section	Binder (8%) Required (Year)					
	2002	2003	2004	2005	2006	
1-3				18,300		
4				15,085	1,676	
5						
6						
7						
8-10				9,772	515	Total
Total	**0**	**0**	**0**	**43,157**	**2,191**	**45,348 TONS**

Roadway Section	Binder (8%) Required (Year)					
	2002	2003	2004	2005	2006	
1-3				16,602		
4				13,685	1,520	
5						
6						
7						
8-10				8,865	467	Total
Total	**0**	**0**	**0**	**39,152**	**1,988**	**41,140 Mg**

Roadway Section	Aggregate (88%) Required (Year)					
	2002	2003	2004	2005	2006	
1-3				201,299		
4				165,937	18,439	
5						
6						
7						
8-10				107,492	5,655	Total
Total	**0**	**0**	**0**	**474,728**	**24,094**	**498,822 TONS**

Roadway Section	Aggregate (88%) Required (Year)					
	2002	2003	2004	2005	2006	
1-3				182,618		
4				150,538	16,728	
5						
6						
7						
8-10				97,517	5,130	Total
Total	**0**	**0**	**0**	**430,673**	**21,858**	**452,531 Mg**

ESTIMATED PROJECT QUANTITIES

ITEM NO.	ITEM CODE	ITEM	UNIT	DESIGN 3502	DESIGN 3602	DESIGN 3702	DESIGN 3802	DESIGN 3902	DESIGN 4002	DESIGN 4102	TOTAL	AS BUILT QUANTITY
1	2414-020020	STEEL FENCE WELDED WIRE MESH	m	115.6	82.1	86.8	244.9	178.9	93.2	269.0	1070.5	
2	2519-422000	REMOVAL OF CHAIN LINK FENCE	m	115.6							115.6	
3	2528-101000	TRAFFIC CONTROL	LS	1							1	
4	2533-100000	MOBILIZATION	LS	1	1	1	1	1	1	1	1	

ITEM NO.	ESTIMATE REFERENCE INFORMATION
2	THE BID ITEM "REMOVAL OF CHAIN LINK FENCE" SHALL INCLUDE ALL COSTS ASSOCIATED WITH DISMANTLING THE EXISTING CHAIN LINK FENCE (APPROXIMATELY 115 878 mm). THE CHAIN LINK FENCES ARE TO BECOME THE PROPERTY OF THE CONTRACTOR.

FENCE DESIGN NO 3502, 50th ST. WEST DES MOINES — MAINT. NO. 7700 10235 FHWA NO 012511
FENCE DESIGN NO. 3602, 42nd ST. WEST DES MOINES — MAINT. NO 7701 20235 FHWA NO. 042171
FENCE DESIGN NO. 3702, 28th ST. WEST DES MOINES — MAINT. NO. 7702.20235 FHWA NO. 042191
FENCE DESIGN NO 3802, COTTAGE GROVE DES MOINES — MAINT. NO. 7706 90235 FHWA NO 042431
FENCE DESIGN NO. 3902, MLK BLVD. DES MOINES — MAINT. NO. 7707.40235 FHWA NO 600565
FENCE DESIGN NO 4002, E 6th ST. DES MOINES — MAINT NO 7709 10235 FHWA NO 600680
FENCE DESIGN NO. 4102, E 9th ST. DES MOINES — MAINT. NO 7709.30235 FHWA NO 004111

77

TRAFFIC CONTROL PLAN

NOTE: I-235 AND 50th ST. WILL BE OPEN TO THRU TRAFFIC. APPROVAL FROM THE ENGINEER IS REQUIRED BEFORE SETTING UP TRAFFIC CONTROL. 42nd ST., 28th ST., COTTAGE GROVE, MLK, E. 6th ST., AND E. 9th ST. WILL BE CLOSED TO TRAFFIC DURING CONSTUCTION. SEE TRAFFIC CONTROL PLAN ON THE ROAD PLAN IN THESE PLANS.

SPECIFICATIONS:

DESIGN: AASHTO SERIES OF 1996.
ALLOWABLE STRESSES AND LOADING INFORMATION HAVE BEEN CONVERTED TO METRIC

CONSTRUCTION: IOWA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION, SERIES 2001, PLUS CURRENT SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS SHALL APPLY TO CONSTRUCTION WORK ON THIS PROJECT PLUS SPECIAL PROVISIONS FOR CLEANING, SURFACE PREPARATION, AND PAINTING OF GALVANIZED SURFACES

DESIGN STRESSES:

DESIGN STRESSES FOR THE FOLLOWING MATERIALS ARE IN ACCORDANCE WITH THE AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, SERIES OF 1996. ALLOWABLE STRESSES AND LOADING INFORMATION HAVE BEEN CONVERTED TO A METRIC VERSION.

STRUCTURAL STEEL POST SHALL COMPLY WITH A709M, GRADE 345. ALL OTHER STRUCTURAL STEEL MATERIAL SHALL COMPLY WITH ASTM A709M, GRADE 250 MINIMUM.

GENERAL NOTES:

THE INTENT OF THIS DESIGN IS FOR THE INSTALLATION WELDED WIRE MESH STEEL FENCES ON POLK COUNTY DESIGN NO. 700, 102, 202, 502, 602 802 AND 902. PLANS OF THE EXISTING STRUCTURES WILL BE MADE AVAILABLE TO THE CONTRACTOR. CONTACT THE OFFICE OF CONTRACTS - PROJECT DEVELOPMENT DIVISION - IOWA DEPARTMENT OF TRANSPORTATION - AMES.

"REMOVALS AS PER PLAN" INCLUDE ALL COSTS ASSOCIATED WITH REMOVING THE EXISTING CHAIN LINK FENCE ON DESIGN 3502. REMOVALS SHALL BE IN ACCORDANCE WITH SECTION 2401 OF THE STANDARD SPECIFICATIONS. ANY DAMAGE TO OTHER PORTIONS OF THE EXISTING STRUCTURE NOT NOTED FOR REMOVAL SHALL BE REPAIRED AT NO EXTRA COST TO THE STATE.

THE CITY AND UTILITY COMPANIES WHOSE FACILITIES ARE SHOWN ON THE PLANS OR KNOWN TO BE WITHIN THE CONSTRUCTION LIMITS SHALL BE NOTIFIED BY THE BRIDGE CONTRACTOR OF THE CONSTRUCTION STARTING DATE.

THE BRIDGE CONTRACTOR IS ENCOURAGED TO TAKE FULL ADVANTAGE OF SPECIFICATION 1105.15 -- VALUE ENGINEERING INCENTIVE PROPOSAL. A PAMPHLET AND CONCEPTUAL PROPOSAL FORM WILL BE AVAILABLE AT THE PRECONSTRUCTION CONFERENCE.

ALL DIMENSIONS IN MILLIMETERS (mm) UNLESS OTHERWISE NOTED OR SHOWN.

ALL ELEVATIONS ON THESE PLANS SHOWN IN METERS (m).

ALL STATIONS SHOWN IN METERS (m).

THE BRIDGE CONTRACTOR SHALL WORK IN SUCH A MANNER THAT EQUIPMENT AND MATERIALS SHALL NOT BE ALLOWED TO INTERFERE WITH TRAFFIC OR BE ALLOWED TO FALL ON THE ROADWAY BELOW.

DURING CONSTRUCTION OF THIS PROJECT THE BRIDGE CONTRACTOR WILL BE REQUIRED TO COORDINATE OPERATIONS WITH THOSE OF OTHER CONTRACTORS WORKING WITHIN THE SAME AREA. OTHER WORK IN PROGRESS DURING THE SAME PERIOD OF TIME WILL INCLUDE, BUT IS NOT LIMITED TO, CONSTRUCTION OF THE FOLLOWING PROJECTS:

IM-235-2(270)--13-77	BRIDGE DESIGN NO. 700 (50th STREET)
IM-235-2(272)2--13-77	BRIDGE DESIGN NO 102 (42nd STREET)
IM-235-2(275)2--13-77	BRIDGE DESIGN NO 202 (28th STREET)
IM-235-2(304)7--13-77	BRIDGE DESIGN NO. 502 (COTTAGE GROVE)
IM-235-2(306)7--13-77	BRIDGE DESIGN NO 602 (MLK BLVD)
IM-235-2(326)9--13-77	BRIDGE DESIGN NO. 802 (E 6th STREET)
IM-235-2(330)9--13-77	BRIDGE DESIGN NO. 932 (E 9th STREET)

FENCE ESTIMATE SHEET

IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

POLK COUNTY | PROJECT NUMBER IM-235-2(468)--13-77 | SHEET NUMBER 2

APPENDIX C: Inspectors

INSPECTORS

Number of Inspectors:

Bridge	1
Grade and Pave	2 to 3
Culvert	1
Noise Wall	1

10/21/2001

SECT	PAR	LETTING	WORK	No. Insp.
			2000	
1 - 3			50th St. Interchange (By City of West Des Moines)	
			2001	
			2002	
gen.			ITS Technology	
1 - 3	(272)	1-15-02	42nd St. Bridge Repl'mt., incl. approach	1
1 - 3	(425)	2-19-02	Noise Wall - 35th to 28th (S. side)	1
1 - 3	(275)	1-15-02	28th St. Bridge Repl'mt., incl. approach	1
1 - 3	(375)	1-15-02	Culvert Extension, 28th St.	1
5	(304)	11-6-01	Cottage Grove Bridge Relocation, incl. bridge removal	1
5	(305)	3-26-02	Cottage Grove - MLK Blvd grade & pave	3
5	(306)	11-6-01	ML King Blvd Bridge Repl'mt.	1
6	(326)	11-6-01	E. 6th St. Bridge Repl'mt.	1
6	(330)	1-15-02	E. 9th St. Bridge Repl'mt.	1
7	(344)	12-14-01	WB Exit at University Bridge (over RR) Repl'mt.	1
7	(347)	12-14-01	E. 21st St. WB Bridge Repl'mt.	1
7	(340)	12-14-01	WB Grading - University to Guthrie, incl. Sec.6 retaining walls (E.9th to E.14th)	2
7	(349)	12-14-01	Easton WB Bridge - New	1
7	(351)	2-19-02	Noise Wall - Easton to Guthrie (W. side)	1
7	(387)	12-14-01	Pedestrian Overpass at Washington, Removal	1
8 - 10	(406)		Signals at Guthrie	
				18
			2003	
gen.			Various Retaining Walls	
1 - 3	(401)	10-29-02	35th St. Interchange SE ramp grading	2
1 - 3	(407)	3-25-03	Noise Wall - Center St. Pl. (N. side)	1
4	(364)	3-25-03	Noise Wall - 63rd St. Ramp A	1
4	(294)	10-29-02	Polk Blvd Bridge Repl'mt. (Staged), incl. part of retaining wall	1
4	(364)	3-25-03	Noise Wall - 56th to 42nd St. (S. side)	1
4	(364)	3-25-03	Noise Wall - 42nd St. Ramp A	1
4		2-18-03	35th St. sideroad reconstruction	1
4	(364)	3-25-03	Noise Wall - 31st to 28th St. (both sides)	1
5			19th St. grade & pave	3
5	(307)	10-29-02	19th St. Bridge Repl'mt., incl. 2 ret. walls & MLK bridge removal	2
5		7-16-02	3rd St. ramps & CD roads (both sides W of 3rd), G / P both W & E River Drive	1
5	(320)	9-24-02	3rd St. Bridge Repl'mt.	1
5		7-16-02	2nd Ave. retaining walls	1
5	(321)	9-24-02	2nd Ave. Bridge Repl'mt., incl. approach, School St. (3rd to DsM river)	1
6	(322)	10-29-02	Bridge Widening EB Ramp & ML over DsM River	1
6	(324)	10-28-03	Bridge Widening WB Ramp & ML over DsM River	1
6	(327)	1-14-03	Pedestrian Overpass at Botanical Cntr	1
6	(329)	3-25-03	Ramps & CD Roads between E. 6th & E. 15th St., incl. sideroads (E.6th, Penn., E.12th)	1
6	(328)	10-29-02	Pennsylvania Ave. Bridge Repl'mt., incl. E.6th bridge removal	1
7	(331)	10-29-02	E. 12th St. Bridge Repl'mt., incl. soil nail wall at bridge	1
7	(341)	10-29-02	WB Paving - University to Guthrie	3
7	(404)	2-18-03	Noise Wall - E.16th to Walker (N. side)	1
	(389)	10-29-02	Noise Wall - Easton to Guthrie (E. side)	1
8 - 10	(405)	10-29-02	Noise Walls - South of Hull Ave. (E. side, Morton to Sheridan)	1
8 - 10	(405)	10-29-02	Noise Walls - South of Hull Ave. (W. side)	1
8 - 10		1-14-03	6" Resurfacing Euclid Ave. Interchange, Bridge Repl'mt, Euclid Ave. reconstruction	1
				32
			2004	
gen.		10-28-03	Mainline Widen and Resurfacing (EB / WB)	3
1 - 3	(430)	10-28-03	Reconstruct 35th St. Interchange	1
1 - 3	(274)	10-28-03	35th St. Bridge Repl'mt.	1
1 - 3	(373)	10-28-03	Culvert Extension, 35th St.	1
1 - 3	(374)	10-28-03	RCB, Stage 2 NE quad of 35th	1
1 - 3	(376)	10-28-03	Culvert Extension, between 28th & 22nd	1
1 - 3	(277)	10-28-03	Bridge median over 22nd	1
1 - 3	(279)	10-28-03	Bridge median over 17nd	1
1 - 3	(377)	10-28-03	RCB east of 17th	1
1 - 3	(281)	10-28-03	6" Resurfacing 73rd St. Interchange - S. side (DsM)	2
1 - 3	(411)	10-28-03	6" Resurfacing 73rd St. Interchange - N. side (DsM)	2
4	(286)	9-26-03	Reconstruct 63rd St. Interchange	1
4	(287)	9-26-03	63rd St. Bridge Repl'mt. (Staged)	1
4	(246)	9-26-03	Culvert Extension, 0.25 km W. of 56th	1
4	(290)	10-28-03	Pedestrian Overpass at 44th St.	2
4	(295)	10-28-03	Reconstruct 42nd St. Interchange	2

4	(296)	10-28-03	42nd St. Bridge Repl'mt.	1
4	(291)	10-28-03	Pedestrian Overpass E. of 42nd St.	2
4	(297)	10-28-03	Bridge Widening WB over 35th	2
4		2-17-04	28th St. sideroad reconstruction (DsM)	1
5	(314)	10-28-03	Ramps & CD Roads between 9th St. & the DsM River	2
5	(315)	10-28-03	7th St. Bridge Repl'mt., incl. approach & 2 ret. walls	2
5	(316)	10-28-03	6th Ave. Bridge Repl'mt. (includes bridge removal)	1
5	(318)	7-15-03	5th Ave. Bridge Repl'mt., incl. approach	1
6	(332)	9-26-03	Ramp Grade & Pave, E. 13th to Univ. & E.14th / E.15th sideroads	3
6	(333)	10-28-03	E. 14th St. Bridge Repl'mt.	1
7	(392)	12-12-03	Bridge Widening over E. 15th St.	1
7	(335)	10-28-03	EB Entr. Bridge over EB Exit to Univ.	1
7	(372)	10-28-03	WB Mainline Grade & Pave through Univ. interchange	3
7	(338)	10-28-03	University WB Bridge Repl'mt.	1
8 - 10	(346)	10-28-03	WB Bridge over UPRR, Repl'mt.	1
8 - 10	(352)	10-28-03	Bridge Median over Guthrie	1
8 - 10	(356)	10-28-03	Bridge median over Hull	1
8 - 10	(360)	10-28-03	Bridge median over Broadway	1
8 - 10	(362)	10-28-03	Bridge Widening over UPRR	1
				49
			2005	
gen.			Lighting	
gen.		7-13-04	Mainline Reconstruction (limits) (8" resurfacing)	3
gen.			Median Fill earthwork	2
1 - 3	(393)	10-26-04	22nd St. EB Bridge Repl'mt.	1
1 - 3		10-26-04	17th St. sideroad reconstruction	2
1 - 3	(410)	10-26-04	17th St. EB Bridge Repl'mt. (WDsM)	1
1 - 3	(282)	10-26-04	73rd St. EB Bridge Widen / Redeck	1
4	(284)	10-26-04	Walnut Creek EB Bridge Widen / Redeck	1
4	(409)	11-30-04	Cummins Parkway EB Bridge Repl'mt.	1
4	(292)	10-26-04	Reconstruct 56th St. Interchange	2
4	(293)	10-26-04	56th St. Bridge Repl'mt.	1
4	(423)	10-26-04	Culvert Extension @ 56th	1
4	(412)	10-26-04	35th St. EB Bridge Repl'mt	1
4	(299)	10-26-04	Reconstruct 31st St. Interchange	2
4	(300)	10-26-04	31st St. Bridge Repl'mt.	1
4	(302)	10-26-04	28th St. EB Bridge Repl'mt.	1
5		9-24-04	Keo Way Interchange & CD roads (S. side)	2
5	(309)	10-26-04	Keo Way EB Bridge Repl'mt.	1
5	(313)	10-26-04	9th St. Bridge Repl'mt.	1
5	(386)	10-26-04	EB Exit Bridge to 7th, 6th, 5th Streets, Repl'mt.	1
6	(323)	9-24-04	EB Bridge over DsM River, Superstructure Repl'mt.	2
7		10-26-04	E. 15th St. EB Bridge Repl'mt.	1
7	(378)	1-11-05	Ramp Grade & Pave WB entr. from WB Univ. & EB exit to Univ., Reconstruct Univ. Ave.	3
7	(337)	11-30-04	2 - WB Entr. Ramp Bridges from WB Univ., Repl'mt.	2
7	(339)	11-30-04	University EB Bridge Repl'mt.	1
7	(380)	11-30-04	Ramp Grade & Pave, WB exit to Univ.	3
7	(345)	11-30-04	EB Bridge over UPRR, Repl'mt.	1
7	(348)	11-30-04	E. 21st St. EB Bridge Repl'mt.	1
7	(381)	11-30-04	Easton Blvd. & ramp grade & pave	3
7	(350)	11-30-04	Easton EB Bridge - New	1
8 - 10	(353)	11-30-04	Guthrie Ave. EB Bridge Repl'mt.	1
8 - 10	(357)	11-30-04	Hull Ave. EB Bridge Repl'mt.	1
8 - 10	(361)	11-30-04	Broadway Ave. EB Bridge Repl'mt.	1
	(363)	11-30-04	UPRR EB Bridge Deck Overlay	1
			10% additional buffer	**48**
			2006	
gen.		7-12-05	Mainline Reconstruction (limits) (8" resurfacing)	3
gen.			Median Fill earthwork	2
1 - 3	(276)	11-1-05	Reconstruct 22nd St. Interchange (22nd St. and Ramps)	3
1 - 3	(403)	11-1-05	Culvert Extension @ 22nd	1
1 - 3	(278)	11-1-05	22nd St. WB Bridge Repl'mt.	1
1 - 3	(280)	11-1-05	17th St. WB Bridge Repl'mt. (WDsM)	1
1 - 3	(283)	11-1-05	73rd St. WB Bridge Widen / Redeck	1
1 - 3	(285)	11-1-05	Walnut Creek WB Bridge Widen / Redeck	1
4	(289)	12-13-05	Cummins Parkway WB Bridge Repl'mt.	1
4	(298)	11-1-05	35th St. WB Bridge Repl'mt.	1
4	(303)	11-1-05	28th St. WB Bridge Repl'mt	1
5		12-13-05	Keo Way Interchange & CD roads (N. side)	2
5	(312)	12-13-05	WB CD Bridge over Keo Way, Repl'mt.	1
5	(310)	12-13-05	Keo Way WB Bridge Repl'mt	1
5	(319)	11-1-05	EB Entrance between 5th Ave. & 4th St. Bridge Repl'mt.	2
5	(325)	12-13-05	WB Bridge over DsM River, Superstructure Repl'mt.	3
7		11-1-05	E. 15th St. WB Bridge Repl'mt.	1
8 - 10	(413)	12-13-05	Guthrie Ave. WB Bridge Repl'mt.	1
8 - 10	(414)	11-1-05	Hull Ave. WB Bridge Repl'mt.	1
8 - 10	(415)	11-1-05	Broadway Ave. WB Bridge Repl'mt.	1
8 - 10	(416)	11-1-05	UPRR WB Bridge Deck Overlay	1
			10% additional buffer	**30**

TOTAL **177**

INSPECTORS (shared)

SECT	PAR	LETTING	WORK	No. Insp. Shared
			2000	
1 - 3			50th St. Interchange (By City of West Des Moines)	
			2001	
			2002	
gen.			ITS Technology	
1 - 3	(272)	1-15-02	42nd St. Bridge Repl'mt., incl. approach	1
1 - 3	(275)	1-15-02	28th St. Bridge Repl'mt., incl. approach	
1 - 3	(425)	2-19-02	Noise Wall - 35th to 28th (S. side)	1
1 - 3	(375)	1-15-02	Culvert Extension, 28th St.	
5	(304)	11-6-01	Cottage Grove Bridge Relocation, incl. bridge removal	
5	(305)	3-26-02	Cottage Grove - MLK Blvd grade & pave	2
5	(306)	11-6-01	ML King Blvd Bridge Repl'mt.	
6	(326)	11-6-01	E. 6th St. Bridge Repl'mt.	1
6	(330)	1-15-02	E. 9th St. Bridge Repl'mt.	
7	(344)	12-14-01	WB Exit at University Bridge (over RR) Repl'mt	1
7	(347)	12-14-01	E. 21st St. WB Bridge Repl'mt.	1
7	(340)	12-14-01	WB Grading - University to Guthrie, incl. Sec.6 retaining walls (E.9th to E.14th)	2
7	(349)	12-14-01	Easton WB Bridge - New	1
7	(351)	2-19-02	Noise Wall - Easton to Guthrie (W. side)	1
7	(387)	12-14-01	Pedestrian Overpass at Washington, Removal	1
8 - 10	(406)		Signals at Guthrie	
				12
			2003	
gen.			Various Retaining Walls	
1 - 3	(401)	10-29-02	35th St. Interchange SE ramp grading	2
1 - 3	(407)	3-25-03	Noise Wall - Center St. Pl. (N. side)	1
4	(364)	3-25-03	Noise Wall - 63rd St. Ramp A	1
4	(294)	10-29-02	Polk Blvd Bridge Repl'mt. (Staged), incl. part of retaining wall	1
4	(364)	3-25-03	Noise Wall - 56th to 42nd St. (S. side)	1
4	(364)	3-25-03	Noise Wall - 42nd St. Ramp A	1
4		2-18-03	35th St. sideroad reconstruction	1
4	(364)	3-25-03	Noise Wall - 31st to 28th St. (both sides)	1
5			19th St. grade & pave	1
5	(307)	10-29-02	19th St. Bridge Repl'mt., incl. 2 ret. walls & MLK bridge removal	1
5		7-16-02	3rd St. ramps & CD roads (both sides W of 3rd), G / P both W & E River Drive	1
5	(320)	9-24-02	3rd St. Bridge Repl'mt.	
5		7-16-02	2nd Ave. retaining walls	1
5	(321)	9-24-02	2nd Ave. Bridge Repl'mt., incl. approach, School St. (3rd to DsM river)	
6	(322)	10-29-02	Bridge Widening EB Ramp & ML over DsM River	1
6	(324)	10-28-03	Bridge Widening WB Ramp & ML over DsM River	
6	(327)	1-14-03	Pedestrian Overpass at Botanical Cntr	1
6	(329)	3-25-03	Ramps & CD Roads between E. 6th & E. 15th St., incl. sideroads (E.6th, Penn., E.12th)	1
6	(328)	10-29-02	Pennsylvania Ave. Bridge Repl'mt., incl. E.6th bridge removal	1
7	(331)	10-29-02	E. 12th St. Bridge Repl'mt., incl. soil nail wall at bridge	1
7	(341)	10-29-02	WB Paving - University to Guthrie	2
7	(404)	2-18-03	Noise Wall - E.16th to Walker (N. side)	1
	(389)	10-29-02	Noise Wall - Easton to Guthrie (E. side)	1
8 - 10	(405)	10-29-02	Noise Walls - South of Hull Ave. (E. side, Morton to Sheridan)	1
8 - 10	(405)	10-29-02	Noise Walls - South of Hull Ave. (W. side)	
8 - 10		1-14-03	6" Resurfacing Euclid Ave. Interchange, Bridge Repl'mt, Euclid Ave. reconstruction	1
				24
			2004	
gen.		10-28-03	Mainline Widen and Resurfacing (EB / WB)	2
1 - 3	(430)	10-28-03	Reconstruct 35th St. Interchange	1
1 - 3	(274)	10-28-03	35th St. Bridge Repl'mt.	
1 - 3	(373)	10-28-03	Culvert Extension, 35th St.	1
1 - 3	(374)	10-28-03	RCB, Stage 2 NE quad of 35th	
1 - 3	(376)	10-28-03	Culvert Extension, between 28th & 22nd	1
1 - 3	(277)	10-28-03	Bridge median over 22nd	1
1 - 3	(279)	10-28-03	Bridge median over 17nd	1
1 - 3	(377)	10-28-03	RCB east of 17th	
1 - 3	(281)	10-28-03	6" Resurfacing 73rd St. Interchange - S. side (DsM)	1
1 - 3	(411)	10-28-03	6" Resurfacing 73rd St. Interchange - N. side (DsM)	
4	(286)	9-26-03	Reconstruct 63rd St. Interchange	1
4	(287)	9-26-03	63rd St. Bridge Repl'mt. (Staged)	
4	(246)	9-26-03	Culvert Extension, 0.25 km W. of 56th	1
4	(290)	10-28-03	Pedestrian Overpass at 44th St.	1
4	(295)	10-28-03	Reconstruct 42nd St. Interchange	1
4	(296)	10-28-03	42nd St. Bridge Repl'mt.	
4	(291)	10-28-03	Pedestrian Overpass E. of 42nd St.	1
4	(297)	10-28-03	Bridge Widening WB over 35th	1
4		2-17-04	28th St. sideroad reconstruction (DsM)	1

5	(314)	10-28-03	Ramps & CD Roads between 9th St. & the DsM River	2
5	(315)	10-28-03	7th St. Bridge Repl'mt., incl. approach & 2 ret. walls	2
5	(316)	10-28-03	6th Ave. Bridge Repl'mt. (includes bridge removal)	1
5	(318)	7-15-03	5th Ave. Bridge Repl'mt., incl. approach	1
6	(332)	9-26-03	Ramp Grade & Pave, E. 13th to Univ. & E.14th / E.15th sideroads	1
6	(333)	10-28-03	E. 14th St. Bridge Repl'mt.	1
7	(392)	12-12-03	Bridge Widening over E. 15th St.	1
7	(335)	10-28-03	EB Entr. Bridge over EB Exit to Univ.	1
7	(372)	10-28-03	WB Mainline Grade & Pave through Univ. interchange	1
7	(338)	10-28-03	University WB Bridge Repl'mt.	1
8 - 10	(346)	10-28-03	WB Bridge over UPRR, Repl'mt.	1
8 - 10	(362)	10-28-03	Bridge Widening over UPRR	
8 - 10	(352)	10-28-03	Bridge Median over Guthrie	1
8 - 10	(356)	10-28-03	Bridge median over Hull	1
8 - 10	(360)	10-28-03	Bridge median over Broadway	1
				31
			2005	
gen.			Lighting	
gen.		7-13-04	Mainline Reconstruction (limits) (8" resurfacing)	2
gen.			Median Fill earthwork	
1 - 3	(393)	10-26-04	22nd St. EB Bridge Repl'mt.	1
1 - 3		10-26-04	17th St. sideroad reconstruction	1
1 - 3	(410)	10-26-04	17th St. EB Bridge Repl'mt. (WDsM)	1
1 - 3	(282)	10-26-04	73rd St. EB Bridge Widen / Redeck	1
4	(284)	10-26-04	Walnut Creek EB Bridge Widen / Redeck	1
4	(409)	11-30-04	Cummins Parkway EB Bridge Repl'mt.	1
4	(292)	10-26-04	Reconstruct 56th St. Interchange	2
4	(293)	10-26-04	56th St. Bridge Repl'mt.	1
4	(423)	10-26-04	Culvert Extension @ 56th	
4	(412)	10-26-04	35th St. EB Bridge Repl'mt.	1
4	(299)	10-26-04	Reconstruct 31st St. Interchange	1
4	(300)	10-26-04	31st St. Bridge Repl'mt.	
4	(302)	10-26-04	28th St. EB Bridge Repl'mt.	1
5		9-24-04	Keo Way Interchange & CD roads (S. side)	1
5	(309)	10-26-04	Keo Way EB Bridge Repl'mt.	
5	(313)	10-26-04	9th St. Bridge Repl'mt.	1
5	(386)	10-26-04	EB Exit Bridge to 7th, 6th, 5th Streets, Repl'mt.	1
6	(323)	9-24-04	EB Bridge over DsM River, Superstructure Repl'mt.	2
7		10-26-04	E. 15th St. EB Bridge Repl'mt.	1
7	(378)	1-11-05	Ramp Grade & Pave WB entr. from WB Univ. & EB exit to Univ., Reconstruct Univ. Ave.	2
7	(337)	11-30-04	2 - WB Entr. Ramp Bridges from WB Univ., Repl'mt.	2
7	(339)	11-30-04	University EB Bridge Repl'mt.	1
7	(380)	11-30-04	Ramp Grade & Pave, WB exit to Univ.	1
7	(345)	11-30-04	EB Bridge over UPRR, Repl'mt.	1
	(363)	11-30-04	UPRR EB Bridge Deck Overlay	
7	(348)	11-30-04	E. 21st St. EB Bridge Repl'mt.	1
7	(381)	11-30-04	Easton Blvd. & ramp grade & pave	1
7	(350)	11-30-04	Easton EB Bridge - New	1
8 - 10	(353)	11-30-04	Guthrie Ave. EB Bridge Repl'mt.	1
8 - 10	(357)	11-30-04	Hull Ave. EB Bridge Repl'mt.	1
8 - 10	(361)	11-30-04	Broadway Ave. EB Bridge Repl'mt.	1
			10% additional buffer	**33**
			2006	
gen.		7-12-05	Mainline Reconstruction (limits) (8" resurfacing)	2
gen.			Median Fill earthwork	
1 - 3	(276)	11-1-05	Reconstruct 22nd St. Interchange (22nd St. and Ramps)	1
1 - 3	(403)	11-1-05	Culvert Extension @ 22nd	1
1 - 3	(278)	11-1-05	22nd St. WB Bridge Repl'mt.	1
1 - 3	(280)	11-1-05	17th St. WB Bridge Repl'mt. (WDsM)	1
1 - 3	(283)	11-1-05	73rd St. WB Bridge Widen / Redeck	1
1 - 3	(285)	11-1-05	Walnut Creek WB Bridge Widen / Redeck	1
4	(289)	12-13-05	Cummins Parkway WB Bridge Repl'mt.	1
4	(298)	11-1-05	35th St. WB Bridge Repl'mt.	1
4	(303)	11-1-05	28th St. WB Bridge Repl'mt.	1
5		12-13-05	Keo Way Interchange & CD roads (N. side)	1
5	(310)	12-13-05	Keo Way WB Bridge Repl'mt.	
5	(312)	12-13-05	WB CD Bridge over Keo Way, Repl'mt.	1
5	(319)	11-1-05	EB Entrance between 5th Ave. & 4th St. Bridge Repl'mt.	1
5	(325)	12-13-05	WB Bridge over DsM River, Superstructure Repl'mt.	2
7		11-1-05	E. 15th St. WB Bridge Repl'mt.	1
8 - 10	(413)	12-13-05	Guthrie Ave. WB Bridge Repl'mt.	1
8 - 10	(414)	11-1-05	Hull Ave. WB Bridge Repl'mt.	1
8 - 10	(415)	11-1-05	Broadway Ave. WB Bridge Repl'mt.	1
8 - 10	(416)	11-1-05	UPRR WB Bridge Deck Overlay	1
			10% additional buffer	**21**
			TOTAL	**121**

APPENDIX D: Cost Resourcing

Location	Duration	Letting Date	Actual Cost	Estimated Cost
I-235	**1795 days**	**NA**	**$179,173,381.00**	**426.00 M**
Section 1-3	**1611 days**	**NA**	**$16,887,000.00**	**34.07 M**
74th St. (50th St. Interchange, by City of West DsM)	30 days	NA	7.5	7.50 M
Bridge Fence - 50th	5 days	NA		0.00 M
42nd St. Bridge (PPCB) Repl'mt., Incl. Approch	74 days	01/15/2002 8:00	1.1	1.46 M
Bridge Fence - 42nd	5 days	03/26/2002 8:00		0.00 M
42nd St. Utilities	480 days	NA		0.00 M
Mid Am Elec Dist (Default Dur.)	240 days	NA		0.00 M
McLeod (Default Dur.)	480 days	NA		0.00 M
35th St. (PPCB)	1020 days	NA	$2,460,000.00	7.11 M
Utilities	480 days	NA		0.00 M
W DsM S S (Default Dur.)	480 days	NA		0.00 M
Amoco Pipeline (Default Dur.)	360 days	NA		0.00 M
Noise Wall (35th to 28th, S. side)	60 days	02/19/2002 8:00	0.5	0.50 M
Reconstruction 35th St. Interchange	102 days	01/14/2003 8:00	Unavailable	4.70 M
Utilities	480 days	NA		0.00 M
Mid Am Elec Dist (Default Dur.)	240 days	NA		0.00 M
Qwest (Default Dur.)	480 days	NA		0.00 M
WDsM S S (Default Dur.)	480 days	NA		0.00 M
35th St. Bridge Repl'mt	50 days	01/14/2003 8:00	$1,810,000.00	1.81 M
Bridge Fence	5 days	12/02/2002 8:00		0.00 M
Culvert Extension	60 days	07/19/2002 8:00		0.10 M
28th St.	865 days	NA		1.54 M
Culvert Extension (28th St.)	60 days	01/15/2002 8:00		0.12 M
Culvert Extension (28th St. to 22nd St.)	60 days	10/28/2003 8:00		0.10 M
28th St. Bridge (PPCB) Repl'mt., incl. Appro.	75 days	01/15/2002 8:00	1	1.32 M
Bridge Fence	5 days	03/26/2002 8:00		0.00 M
Utilities	240 days	NA		0.00 M
Mid Am Elec Dist (Default Dur.)	240 days	NA		0.00 M
22nd St. (PPCB)	956 days	NA	$4,347,000.00	9.44 M
Center St. Noise Wall (N. Side)	40 days	03/25/2003 8:00	$500,000.00	0.50 M
Median Bridge	85 days	10/28/2003 8:00	$1,247,000.00	2.04 M
WB ML Bridge Repl'mt.	115 days	10/26/2004 8:00	$1,300,000.00	1.30 M
EB ML Bridge Repl'mt.	115 days	11/01/2005 8:00	$1,300,000.00	1.30 M
Reconstruction 22nd St. Interchange (22nd St. and ramps)	87 days	11/01/2005 8:00	Unavailable	4.20 M
Culvert Extension at 22nd St.	60 days	11/01/2005 8:00		0.10 M
17th St. (PPCB)	685 days	NA	$2,050,000.00	3.92 M
Culvert Extension (E of 17th)	60 days	10/28/2003 8:00		0.11 M
Median Bridge	82 days	10/28/2003 8:00	$850,000.00	1.56 M
WB ML Bridge Repl'mt. (WDsM)	105 days	10/26/2004 8:00	$600,000.00	0.95 M
EB ML Bridge Repl'mt. (WDsM)	105 days	11/01/2005 8:00	$600,000.00	0.60 M
17th St. Sidetoad reconstruction	70 days	10/26/2004 8:00	Unavailable	0.70 M
73rd St. (PPCB)	643 days	NA	$5,000,000.00	3.10 M
6" Resurfacing of 73rd St. Interchange - both sides	100 days	10/28/2003 8:00		0.30 M
WB ML Bridge Widen / Redeck	130 days	10/26/2004 8:00	$2,500,000.00	1.40 M
EB ML Bridge Widen / Redeck	110 days	11/01/2005 8:00	$2,500,000.00	1.40 M
ML	202 days	NA	$100,000.00	0.00 M
G&P (Cost incl. In general activities)	140 days	NA	Unavailable	0.00 M

Location	Duration	Letting Date	Actual Cost	Estimated Cost
Section 4	**1392 days**	**NA**	**$27,983,000.00**	**47.93 M**
Walnut Creek WB Bridge Widen / Redeck	150 days	10/26/2004 8:00		1.80 M
Walnut Creek EB Bridge Widen / Redeck	140 days	11/01/2005 8:00		1.80 M
63rd St. (PPCB)	396 days	NA	$6,966,000.00	7.05 M
Noise Wall (63rd St. Ramp A)	70 days	03/25/2003 8:00	$878,000.00	0.88 M
63rd St. Interchange reconstruction	52 days	09/26/2003 8:00	$4,300,000.00	4.30 M
Bridge Repl'mt	140 days	09/26/2003 8:00	$1,788,000.00	1.87 M
Bridge Fence	5 days	07/15/2003 8:00		0.00 M
Cummins Pkwy (PPCB)	475 days	NA	$2,600,000.00	2.60 M
WB Bridge Repl'mt	152 days	11/30/2004 8:00	$1,300,000.00	1.30 M
EB Bridge Repl'mt	140 days	12/13/2005 8:00	$1,300,000.00	1.30 M
56th St. (PPCB)	716 days	NA	$5,060,000.00	8.04 M
Noise Wall from 56th St. to 42th St. (S. side)	30 days	03/25/2003 8:00	$2,779,000.00	2.78 M
Interchange reconstruction	25 days	10/26/2004 8:00	$3,390,000.00	3.39 M
Bridge Repl'mt	152 days	10/26/2004 8:00	$1,670,000.00	1.67 M
Bridge Fence	5 days	07/15/2003 8:00		0.00 M
Culvert Extension (56th St.)	60 days	10/26/2004 8:00		0.10 M
Culvert Extension (0.25 km W of 56th)	60 days	09/26/2003 8:00		0.10 M
Polk Blvd Bridge	177 days	NA		1.80 M
Demo Concrete Box Beam	14 days	NA		0.00 M
Polk Blvd Bridge Repl'mt, Incl. Part of ret. Wall	100 days	01/14/2003 8:00	$1,590,000.00	1.80 M
Utilities - Polk Blvd	360 days	NA		0.00 M
Mid Am Elec Dist (Default Dur.)	240 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
Bridge Fence - Polk Blvd	5 days	12/02/2002 8:00		0.00 M
Pedestrian Overpass at 44th St.	98 days	10/28/2003 8:00		1.70 M
42nd St. (PPCB)	404 days	NA	$1,978,000.00	10.41 M
Noise Wall (42th St. Ramp A)	30 days	03/25/2003 8:00		0.91 M
42nd Bridge Repl'mt	143 days	10/28/2003 8:00	$1,100,000.00	1.10 M
Bridge Fence	5 days	03/26/2002 8:00		0.00 M
Interchange reconstruction	135 days	10/28/2003 8:00		6.70 M
Pedestrian Overpass E of 42nd St.	98 days	10/28/2003 8:00		1.70 M
35th St. (PPCB)	987 days	NA	$2,866,000.00	2.17 M
35th St. Sideroad Reconstruction	70 days	02/18/2003 8:00	Unavailable	0.00 M
WB ML Bridge Widening (temporary)	30 days	10/28/2003 8:00		0.15 M
EB ML Bridge Repl'mt	111 days	10/26/2004 8:00	$1,008,000.00	1.01 M
WB ML Bridge Repl'mt	90 days	11/01/2005 8:00	$1,008,000.00	1.01 M
31st St (PPCB)	701 days	NA	$2,128,000.00	7.77 M
Noise Wall (31st to 28th, both side)	30 days	03/25/2003 8:00	$878,000.00	0.88 M
31st St. Bridge	260 days	NA		1.25 M
Demo Concrete Box Beam	14 days	NA		0.00 M
31st St. Bridge Repl'mt	100 days	10/26/2004 8:00	$1,250,000.00	1.25 M
Interchange reconstruction	57 days	10/26/2004 8:00		5.64 M
Bridge Fence	5 days	07/15/2003 8:00		0.00 M
28th St. (PPCB)	951 days	NA	$2,016,000.00	2.79 M
Noise Wall (28th St. to Cottage, N. side)	30 days	NA	Unavailable	0.00 M
28th St. Sideroad Reconstruction	65 days	02/17/2004 8:00	Unavailable	0.70 M
EB ML Bridge Repl'mt	126 days	10/26/2004 8:00	$1,008,000.00	1.01 M
WB ML Bridge Repl'mt	110 days	11/01/2005 8:00	$1,008,000.00	1.08 M
Ret. Wall (S of 28th St.)	50 days	NA		0.00 M
ML (Reconstruction, Cost incl. In general activities)	142 days	NA		0.00 M

Location	Duration	Letting Date	Actual Cost	Estimated Cost
Section 5	**1738 days**	**NA**	**$53,681,077.00**	**58.20 M**
Cottage Grove	699 days	NA	$2,060,000.00	7.59 M
Cottage Bridge	254 days	NA		2.29 M
Demo Concrete Box Beam	14 days	NA		0.00 M
Bridge Relocation, incl. Bridge removal	100 days	12/14/2001 8:00	$2,060,000.00	2.29 M
Cottage Grove - MLK Blvd G & P	100 days	03/26/2002 8:00	Unavailable	5.30 M
Traffic Signals Lighting - MLK Blvd. & Cottage Grove	10 days	06/04/2002 8:00		0.00 M
Lighting	480 days	NA		0.00 M
Mid Am Elec Dist (Default Dur.)	240 days	NA		0.00 M
Mid Am Gas (Default Dur.)	240 days	NA		0.00 M
Qwest (Default Dur.)	480 days	NA		0.00 M
AT&T Cable (Default Dur.)	480 days	NA		0.00 M
DsM Water Main At Reloc. Cottage Grove (Default Dur.)	360 days	03/26/2002 8:00		0.00 M
DsM S S (Default Dur.)	480 days	NA		0.00 M
Bridge Fence	5 days	03/26/2002 8:00		0.00 M
MLK Pkwy (Steel)	1156 days	NA	$1,760,000.00	1.64 M
MLK Blvd bridge repl'mt	856 days	12/14/2001 8:00	$200,000.00	1.64 M
Demo Concrete Box Beam	14 days	NA		0.00 M
MLK Blvd Bridge Prep.	660 days	NA		0.00 M
Clear Utilities	480 days	NA		0.00 M
Mid Am Elec Dist (Default Dur.)	240 days	NA		0.00 M
Mid Am Gas (Default Dur.)	240 days	NA		0.00 M
Qwest (Default Dur.)	480 days	NA		0.00 M
AT&T Cable (Default Dur.)	480 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
DsM S S (Default Dur.)	480 days	NA		0.00 M
Letting	0 days	12/14/2001 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
MLK Blvd Bridge Construction	255 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Bridge Fence	5 days	03/26/2002 8:00		0.00 M
MLK & 19th Relocation & ramps	480 days	03/26/2002 8:00		0.00 M
24th St. -- S S	480 days	NA		0.00 M
19th St.	216 days	NA		4.90 M
19th St. G&P	140 days	12/02/2002 8:00		2.90 M
19th Bridge	167 days	NA		2.00 M
Demo Concrete Box Beam	14 days	NA		0.00 M
19th St. Bridge Repl'mt, incl. 2 ret. Walls & MLK Bridge removal	100 days	12/02/2002 8:00	$3,413,000.00	2.00 M
Bridge Fence	5 days	12/02/2002 8:00		0.00 M
Keo Way	886 days	NA	$3,428,000.00	11.03 M
EB ML Bridge (Steel) Repl'mt.	288 days	10/26/2004 8:00	$1,714,000.00	1.72 M
EB ML Bridge Prep.	70 days	NA		0.00 M
Clear Utilities	60 days	NA		0.00 M
Letting	0 days	10/26/2004 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
EB ML Bridge Construction	158 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
WB ML Bridge (Steel) Repl'mt.	321 days	12/13/2005 8:00	$1,714,000.00	1.72 M
WB ML Bridge Prep.	104 days	NA		0.00 M
Clear Utilities	60 days	NA		0.00 M

Location	Duration	Letting Date	Actual Cost	Estimated Cost
Letting	0 days	12/13/2005 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
WB ML Bridge Construction	157 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Sanitary Sewer	480 days	NA		0.00 M
Along School St From Keo To 18th St.(S. Side)	480 days	06/04/2002 8:00		0.00 M
Along Day St. From Keo To MLK(N. Side)	480 days	06/04/2002 8:00		0.00 M
Keo Way Interchange & CD Roads (S. side)	114 days	10/26/2004 8:00		5.60 M
Keo Way Interchange & CD Roads (N. side)	98 days	12/13/2005 8:00		1.01 M
WB CD Bridge over Keo Way, Repl'mt.	108 days	12/13/2005 8:00		0.98 M
9th St. Bridge (Steel) Repl'mt	288 days	10/26/2004 8:00	$1,872,000.00	2.90 M
9th St. Bridge Prep.	70 days	NA		0.00 M
Clear Utilities	60 days	NA		0.00 M
Letting	0 days	10/26/2004 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
9th St. Bridge Construction	158 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Bridge Fence - 9th St	5 days	07/15/2003 8:00		0.00 M
Ramps & CD Roads between 9th St. and DsM R.	80 days	10/28/2003 8:00		2.00 M
7th St. Bridge (Steel) Repl'mt., incl. Approach & 2 ret. Walls	289 days	10/28/2003 8:00		1.70 M
7th St. Bridge Prep.	71 days	NA		0.00 M
Clear Utilities	60 days	NA		0.00 M
Letting	0 days	10/28/2003 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
7th St. Bridge Construction	158 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Bridge Fence - 7th St	5 days	07/15/2003 8:00		0.00 M
6th Ave. Bridge (Steel) Repl'mt.(incl. Bridge removal)	289 days	10/28/2003 8:00		1.72 M
6th Ave. Bridge Prep.	71 days	NA		0.00 M
Clear Utilities	60 days	NA		0.00 M
Letting	0 days	10/28/2003 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
6th Ave. Bridge Construction	158 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Bridge Fence - 6th St	5 days	07/15/2003 8:00		0.00 M
5th St. Bridge (Steel) Repl'mt., incl. Approach	706 days	02/18/2003 8:00	$4,470,000.00	1.40 M
5th St. Bridge Prep.	480 days	NA		0.00 M
Clear Utilities	480 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
DsM S S (Default Dur.)	480 days	NA		0.00 M
Letting	0 days	02/18/2003 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
5th St. Bridge Construction	166 days	NA		0.00 M

Location	Duration	Letting Date	Actual Cost	Estimated Cost
Substructure	75 days	NA		0.00 M
Superstructure	45 days	NA		0.00 M
EB Exit bridge to 7th, 6th, 5th St, Repl'mt.	152 days	10/26/2004 8:00		0.92 M
EB Entrance between 5th Ave. & 4th St. Bridge Repl'mt.	150 days	11/01/2005 8:00		0.68 M
3rd St.	648 days	NA		9.50 M
3rd St. Ramps & CD roads (both sides W of 3rd), 2nd St. r-walls, G&P both W & E River Dr, School St. (3rd to DsM R.)	89 days	07/16/2002 8:00		7.70 M
Utilities	360 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
3rd St. Bridge (Steel) Repl'mt	326 days	07/16/2002 8:00		1.80 M
3rd St. Bridge Prep.	60 days	NA		0.00 M
Clear Utilities	60 days	NA		0.00 M
Letting	0 days	07/16/2002 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
3rd St. Bridge Construction	206 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Utilities	360 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
Bridge Fence	5 days	12/02/2002 8:00		0.00 M
2nd Ave.	612 days	NA		1.90 M
2nd Ave. Bridge (Steel) Repl'mt., incl. Approach, School St. (3rd to DsM river)	606 days	08/20/2002 8:00	$3,520,000.00	1.90 M
2nd Ave. Bridge Prep.	360 days	NA		0.00 M
Clear Utilities	360 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
Letting	0 days	08/20/2002 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
2nd Ave. Bridge Construction	186 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Bridge Fence	5 days	12/02/2002 8:00		0.00 M
DsM Rvr Bridge (Steel)	998 days	NA	$9,617,000.00	10.32 M
Bridge widening (WB/EB) Ramp & ML over DsM River	150 days	08/20/2002 8:00	$5,017,000.00	5.72 M
EB Bridge, Superstructure Repl'mt.	726 days	09/24/2004 8:00	$2,400,000.00	2.40 M
EB Bridge, Superstructure Prep.	480 days	NA		0.00 M
Clear Utilities	480 days	NA		0.00 M
Mid Am Elec Dist (Default Dur.)	240 days	NA		0.00 M
Qwest (Default Dur.)	480 days	NA		0.00 M
McLeod (Default Dur.)	480 days	NA		0.00 M
Letting	0 days	09/24/2004 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
EB Bridge, Superstructure Construction	120 days	NA		0.00 M
Superstructure	100 days	NA		0.00 M
WB Bridge, Superstructure Repl'mt.	681 days	12/13/2005 8:00	$2,200,000.00	2.20 M
WB Bridge, Superstructure Prep.	480 days	NA		0.00 M
Clear Utilities	480 days	NA		0.00 M

Location	Duration	Letting Date	Actual Cost	Estimated Cost
Mid Am Elec Dist (Default Dur.)	240 days	NA		0.00 M
Mid Am Gas (Default Dur.)	240 days	NA		0.00 M
Qwest (Default Dur.)	480 days	NA		0.00 M
McLeod (Default Dur.)	480 days	NA		0.00 M
Letting	0 days	12/13/2005 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
WB Bridge, Superstructure Construction	81 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
ML	382 days	NA	$23,541,077.00	0.00 M
G&P	382 days	NA	$23,541,077.00	0.00 M
EB (Cost incl. In general activities)	100 days	11/10/2004 8:00	$11,556,763.00	0.00 M
WB (Cost incl. In general activities)	100 days	11/10/2005 8:00	$11,984,314.00	0.00 M

Location	Duration	Letting Date	Actual Cost	Estimated Cost
Sec 6	**1705 days**	**NA**	**$54,821,304.00**	**32.96 M**
E6th St Bridge Repl'mt (Steel)	566 days	01/15/2002 8:00	$1,360,000.00	1.28 M
E6th St Bridge Prep.	480 days	NA		0.00 M
Clear Utilities	360 days	NA		0.00 M
Letting	0 days	02/19/2002 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
E6th St Bridge Construction	119 days	NA		0.00 M
Abutments	50 days	NA		0.00 M
Jack Storm Sewer Pipe	30 days	NA		0.00 M
Center Pier	15 days	NA		0.00 M
Superstructure	69 days	NA		0.00 M
Bridge Fence - E6th	5 days	03/26/2002 8:00		0.00 M
Pesestrian Overpass at Botanical Cntr	181 days	09/27/2002 8:00		1.70 M
Abutment	60 days	NA		0.00 M
Old Ped. Overpass Demo.	30 days	NA		0.00 M
Finish Ped. Bridge	60 days	NA		0.00 M
Ramps E 6th to WB I-235	40 days	10/29/2002 8:00		5.70 M
Ramps & CD Roads between E 6th & E 15th St., incl. Sideroads (E 6th, Penn., E 12 th) except Ramp E 6th to WB I-235	168 days	10/29/2002 8:00		5.70 M
Ramps G&P, E 13th to Univ. & E 14th/ E 15th sideroads	126 days	09/26/2003 8:00		5.70 M
Penn Ave Bridge Repl'mt (Steel), incl. E 6th Bridge removal	577 days	10/29/2002 8:00	$1,900,000.00	1.20 M
Demo Concrete Box Beam - E 6th	14 days	NA		0.00 M
Demo Concrete Box Beam - Penn Ave	14 days	NA		0.00 M
Penn Ave Bridge Prep.	360 days	NA		0.00 M
Clear Utilities	360 days	NA		0.00 M
Letting	0 days	10/29/2002 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
Penn Ave Bridge Construction	157 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Bridge Fence - Penn Ave	5 days	12/02/2002 8:00		0.00 M
E9th St bridge Repl'mt (Steel)	742 days	01/15/2002 8:00	$1,510,000.00	2.45 M
Demo Concrete Box Beam	14 days	NA		0.00 M
E9th St bridge Prep.	601 days	NA		0.00 M
Clear Utilities	480 days	NA		0.00 M
Mid Am Gas (Default Dur.)	240 days	NA		0.00 M
Qwest (Default Dur.)	480 days	NA		0.00 M
AT&T Cable (Default Dur.)	480 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
DsM S/ST S (Default Dur.)	480 days	NA		0.00 M
Letting	1 day	01/15/2002 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
E9th St bridge Construction	199 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	66 days	NA		0.00 M
Bridge Fence - E9th	5 days	03/26/2002 8:00		0.00 M
Utilities (E9th to E12th)	480 days	NA		0.00 M
Mid Am Gas (Default Dur.)	240 days	NA		0.00 M
Qwest (Default Dur.)	480 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
AT&T Cable (Default Dur.)	480 days	NA		0.00 M
DsM S S (Default Dur.) -- Maple	480 days	03/26/2002 8:00		0.00 M
Soilnail Walls (E 9th to E 12th)	45 days	NA		0.00 M

Location	Duration	Letting Date	Actual Cost	Estimated Cost
Utilities (E12th to E14th)	480 days	NA		0.00 M
Mid Am Elec Dist (Default Dur.)	240 days	NA		0.00 M
Mid Am Gas (Default Dur.)	240 days	NA		0.00 M
Qwest (Default Dur.)	480 days	NA		0.00 M
McLeod (Default Dur.)	240 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
DsM S S (Default Dur.)	480 days	NA		0.00 M
East High School Water Line	360 days	NA		0.00 M
E12th St Bridge Repl'mt (Steel), incl. Soil nail wall at bridge	702 days	10/29/2002 8:00	$1,660,000.00	3.00 M
Demo Concrete Box Beam	14 days	NA		0.00 M
E12th St Bridge Prep.	482 days	NA		0.00 M
Clear Utilities	480 days	NA		0.00 M
Mid Am Elec Dist (Default Dur.)	240 days	NA		0.00 M
McLeod (Default Dur.)	480 days	NA		0.00 M
Letting	1 day	10/29/2002 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
E12th St Bridge Construction	155 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Bridge Fence - E12th St	5 days	12/02/2002 8:00		0.00 M
E14th St Bridge (Steel) Repl'mt	1069 days	10/28/2003 8:00	$6,224,000.00	2.36 M
E14th St Bridge Prep.	851 days	NA		0.00 M
Clear Utilities	480 days	NA		0.00 M
Sanitary Sewer At East High School & E. 14th St.	480 days	04/30/2002 8:00		0.00 M
Letting	0 days	10/28/2003 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
E14th St Bridge Construction	158 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Bridge Fence - E14th St	5 days	07/15/2003 8:00		0.00 M
E 15th St Bridge Widening	110 days	12/12/2003 8:00		1.01 M
E 15th St Bridge EB Repl'mt.	123 days	10/26/2004 8:00		1.43 M
E 15th St Bridge WB Repl'mt.	123 days	11/01/2005 8:00		1.43 M
ML	382 days	NA	$42,167,304.00	0.00 M
EB (Cost incl. In general activities)	100 days	03/25/2003 8:00	$10,541,826.00	0.00 M
WB (Cost incl. In general activities)	100 days	03/25/2003 8:00	$31,625,478.00	0.00 M

Location	Duration	Letting Date	Actual Cost	Estimated Cost
Sec 7, 8-10	**1750 days**	**NA**	**$25,801,000.00**	**47.32 M**
Univ Ave Area	1493 days	NA	$14,081,000.00	21.83 M
Pedestrian Overpass at Washington, Removal	60 days	03/26/2002 8:00		0.10 M
Reconstruct Univ. Ave.	140 days	01/14/2003 8:00		1.65 M
Noise Wall from E 16th to Walker (N side)	70 days	02/18/2003 8:00		0.39 M
EB Entr. Bridge over EB Exit at Univ.	82 days	10/28/2003 8:00		0.85 M
WB ML G&P thru Univ. Int (incl Bridge over Univ & UPRR, different contractors)	480 days	10/28/2003 8:00	Unavailable	1.20 M
Utility	480 days	NA		0.00 M
Fiber Optical - Ramp A	480 days	NA		0.00 M
Parcel 117 occupied by former owner	30 days	NA		0.00 M
WB Grading - Univ. to Guthrie	80 days	04/30/2002 8:00	$2,400,000.00	3.50 M
Utilities	480 days	NA		0.00 M
Mid Am Gas (Default Dur.)	240 days	NA		0.00 M
Qwest (Default Dur.)	480 days	NA		0.00 M
DsM W W (At Washington Ave., Default Dur.)	360 days	03/26/2002 8:00		0.00 M
WB Paving - Univ. to Guthrie	123 days	10/29/2002 8:00		2.70 M
Ramp G&P WB entr. (WB Univ & EB Exit to Univ.), reconstruction Univ. Ave.	85 days	01/11/2005 8:00		0.00 M
EB Exit ramp to EB Univ. - G&P	100 days	10/28/2003 8:00		0.00 M
WB Exit ramp to Univ. - G&P	100 days	10/29/2002 8:00		0.00 M
Ramp G&P, WB exit to (& entr. From) WB Univ., EB exit to Univ., Reconstruct Univ. Ave.	110 days	10/29/2002 8:00		1.23 M
WB Exit at Univ. Bridge (over RR) Repl'mt.	70 days	03/28/2002 8:00		0.60 M
WB Univ. Ave. ramp to WB I-235 bridge	82 days	11/30/2004 8:00	$850,000.00	0.81 M
WB Univ. Bridge Repl'mt. (Steel)	288 days	10/28/2003 8:00		3.80 M
Demo Concrete Box Beam	14 days	NA		0.00 M
WB Bridge Prep.	70 days	NA		0.00 M
Clear Utilities	60 days	NA		0.00 M
Letting	0 days	10/28/2003 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
WB Bridge Construction	158 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
EB Univ. Bridge Repl'mt. (Steel)	310 days	11/30/2004 8:00		3.00 M
Demo Concrete Box Beam	14 days	NA		0.00 M
EB Bridge Prep.	95 days	NA		0.00 M
Clear Utilities	60 days	NA		0.00 M
Letting	0 days	11/30/2004 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
EB Bridge Construction	154 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
E 21 St. Utility	481 days	NA		0.00 M
DsM Storm Sewer	480 days	NA		0.00 M
Near Easton Blvd. & E 21 St. -- S S	480 days	NA		0.00 M
Demo Concrete Box Beam - E 21 St. WB	14 days	NA		0.00 M
E 21 St. WB Bridge (PCCB) Repl'mt.	112 days	03/28/2002 8:00		0.90 M

Location	Duration	Letting Date	Actual Cost	Estimated Cost
Demo Concrete Box Beam - E 21 St. EB	14 days	NA		0.00 M
E 21 St. EB Bridge (PCCB) Repl'mt. - incl. Ramp bridge	112 days	11/30/2004 8:00		1.10 M
Noise Wall	1168 days	NA	$4,606,000.00	4.20 M
Utilities	480 days	NA		0.00 M
Mid Am Gas (Default Dur.)	240 days	NA		0.00 M
Qwest (Default Dur.)	480 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
DsM S S (Default Dur.)	480 days	NA		0.00 M
Easton to Guthrie Noise Wall (W side)	70 days	02/19/2002 8:00	$2,100,000.00	2.10 M
Utilities	480 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
Thompson / Tichenor St. -- S S	480 days	04/30/2002 8:00		0.00 M
Easton to Guthrie Noise Wall (E side)	70 days	01/11/2005 8:00	$2,506,000.00	2.10 M
Easton Blvd. & ramps G&P	48 days	11/30/2004 8:00		1.20 M
Easton WB Bridge (Steel) - New, Incl. Pedestrian Overpass at Washington, Removal"	279 days	03/28/2002 8:00		1.70 M
Easton WB Bridge Prep.	30 days	NA		0.00 M
Clear Utilities	30 days	NA		0.00 M
Letting	0 days	03/28/2002 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
Easton WB Bridge Construction	189 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	24 days	NA		0.00 M
Easton EB Bridge (Steel) - New	275 days	11/30/2004 8:00	$1,200,000.00	1.76 M
Easton EB Bridge Prep.	61 days	NA		0.00 M
Clear Utilities	60 days	NA		0.00 M
Letting	0 days	11/30/2004 8:00		0.00 M
Fabricate Steel	120 days	NA		0.00 M
Easton EB Bridge Construction	154 days	NA		0.00 M
Substructure	75 days	NA		0.00 M
Superstructure	75 days	NA		0.00 M
Guthrie Ave. (PPCB)	688 days	NA	$2,440,000.00	1.96 M
Median Bridge	82 days	10/28/2003 8:00	$700,000.00	0.70 M
EB Bridge Repl'mt.	105 days	11/30/2004 8:00	$870,000.00	0.63 M
WB Bridge Repl'mt.	108 days	12/13/2005 8:00	$870,000.00	0.63 M
Interchange	96 days	NA	Unavailable	0.00 M
Median fill (Guthrie to Hull)	80 days	NA	Unavailable	0.00 M
EB G&P (Guthrie to Hull)	142 days	NA	Unavailable	0.00 M
WB G&P (Guthrie to Hull)	140 days	NA	Unavailable	0.00 M
Hull Ave. (PPCB)	1323 days	NA	$3,000,000.00	3.60 M
Median Bridge	97 days	10/28/2003 8:00	$800,000.00	1.00 M
EB Bridge Repl'mt.	120 days	11/30/2004 8:00	$1,100,000.00	0.90 M
WB Bridge Repl'mt.	123 days	11/01/2005 8:00	$1,100,000.00	0.90 M
Noise Wall - S. of Hull Ave. (E. side, Morton to Sheridan)	80 days	01/14/2003 8:00		0.40 M
Utilities	360 days	NA		0.00 M
DsM W W (Default Dur.)	360 days	NA		0.00 M
Noise Wall - S. of Hull Ave. (W. side)	80 days	01/14/2003 8:00		0.40 M
Euclid Ave. Interchange Resurfacing, Bridge Repl'mt., Euclid Ave. Reconstruction	150 days	10/29/2002 8:00	$2,070,000.00	4.40 M
Bridge Fence - Euclid Ave	5 days	12/02/2002 8:00		0.00 M
ML G&P (W. Euclid to UPRR)	142 days	NA	Unavailable	0.00 M
Broadway Ave. (PPCB)	690 days	NA	$2,110,000.00	1.86 M
Median Bridge	100 days	10/28/2003 8:00	$850,000.00	0.60 M

Broadway Ave. EB Bridge Repl'mt.	110 days	11/30/2004 8:00	$1,260,000.00	0.63 M
Broadway Ave. WB Bridge Repl'mt.	110 days	11/01/2005 8:00		0.63 M
UPRR Bridge (PPCB)	925 days	NA	$2,100,000.00	4.81 M
Median Bridge	138 days	10/28/2003 8:00	$1,700,000.00	0.00 M
Bridge Widening over UPRR	138 days	10/28/2003 8:00		1.70 M
WB Bridge over UPRR, Repl'mt.	125 days	10/28/2003 8:00		1.01 M
EB Bridge over UPRR, Repl'mt.	131 days	11/30/2004 8:00		1.70 M
Utilities	480 days	NA		0.00 M
Fiberoptic	480 days	NA		0.00 M
UPRR EB Bridge Deck Overlay	131 days	11/30/2004 8:00		0.20 M
UPRR WB Bridge Deck Overlay	125 days	11/01/2005 8:00		0.20 M
General Activities	1237 days	NA		205.52 M
ITS Technology	216 days	NA		2.40 M
Various R-Walls	195 days	NA		3.42 M
ML Widen & Resurfacing (EB/WB)	195 days	NA		47.90 M
Lighting	194 days	NA		10.00 M
ML Reconstruction (limits) (8" resurfacing)	194 days	NA		0.00 M
Median Fill earthwork	194 days	NA		1.30 M
ML Reconstruction (limits) (8" resurfacing)	194 days	NA		64.00 M
Median Fill earthwork	194 days	NA		0.00 M
Cost not included above	1237 days	NA		76.50 M

REFERENCES

Brockenbrough, Roger L. and Kenneth J. Boedecker, Jr.. *Highway Engineering Handbook: Building and Rehabilitating the Infrastructure*. New York: McGraw-Hill Companies, 1996.

Callahan, M.T., Quackenbush, D.G. and Rowings, J.E.*Construction Project Scheduling*. McGraw-Hill, Inc., 1992.

Ringwald, Richard C., and Francis J. Hopcroft, PE. *Means Heavy Construction Handbook*. Kingston, Ma: R.S. Means Company, Inc., 1993.

Willis, Edward M. *Scheduling Construction Projects*. New York: John Wiley & Sons, 1986.