Cost Estimating Considerations

Earthwork Projects

Peter Davis
Vice President – Edgerton Contractors

Matt Grove
Director of Construction Policy
WTBA

WisDOT comments included in red textboxes.

Estimating vs Bidding

Estimating

1) *…to calculate approximate amount or value of something*

2) … to form an opinion about or evaluate

3) … How is Contractor Going to Bid (not found in any dictionary)

Bid

1) *…To offer or propose (an amount)*
(Contractually Binding)

How Do Contractors Estimate ?

Calculate Known Costs (Labor, Machinery, Trucking, Materials, Soil Disposal Sites, Safety)

Consider Unknown Factors (Traffic, Weather, Schedule Compression, Soil Condition, Material Shortages)

- Determine Potential Risk Associated With Unknown Costs Based on Experience
- Assign Cost to Risks

Summarize Total Known and Unknown Costs

Add Overhead

Add Profit to Determine Bid Price

- Profit Level Determined by Need for Work, Familiarity with Project/Location, Risk Level

The $Million ? (or much more!)

How Attractive Have You Made The Project to the Construction Industry ?

Your Design / Contract Affects Price !

Are You Promoting Competition (Primes and Subs) ?

- Accurate (Biddable) Plans and Quantities
- Appropriate Risk Allocation (Too Much Risk Transferred to Contractor?)
- Constructible Schedule

What Creates Variability In Bids? (The Big Three)

Schedule
- Staging – Shifts - Mobilizations
- Night Work
- Overall Schedule Compression
- Short Work Windows
- Large LD's

Utilities
- Relocation During Construction ?
- Unknowns – Trans 220 Recovery a Risk

Environmental
- Risk
- Work Limitations

Plan and Specs

Good Plans and Accurate Quantities Promote More Confident and Aggressive Pricing

Inaccurate Plans Cause Problems
- Lack of Confidence / Uncertainty Promotes More Conservative Pricing
- Contractors Find Problems Quickly and May Take Advantage of Mistakes

Undistributed Quantities Can Create Problems – Especially on Blended Items (Example Later)

Unusual or Unnecessary Incidental Items Cause Confusion and May Unnecessarily Elevate Prices
- Water
- MSE Wall Coping
- Granular Backfill for EBS

Pay Plan Quantity (PPQ) Items Increase Risk for Contractor
- Common Excavation
- Aggregate Base / Select Crushed / Breaker Run
- MSE Walls
- Ice for Structures

Ice for structures is <u>not</u> a pay plan quantity and rarely was a bid into projects this way. This should not be viewed as a risk to contractors.

This should not be viewed as a risk to contractors.
MSE wall copings (not anchor slabs which have concrete parapets or steel railings above) are always bid as part of the wall cost. This should not be viewed as an "unusual" incidental item. There is no way a designer can calculate this quantity because the wall panel suppliers dictate panel layouts, which affects how much concrete is required for the coping.

Other Considerations

Urban Projects
- Lack of Staging Areas
- Pedestrian Accommodation Responsibility
- Traffic
- Buildings

Time of Year (Late Fall / Winter / Early Spring Conditions)
- Safety (Slip/Trip/Fall, Vehicle Traction, Frostbite)
- Constructability (Frost Removal/Protection, Soil Compaction)
- Productivity Reduction in Cold/Wet Weather

Time of Let - Let Complex Projects Early
- Contractors More Aggressive Earlier in the Year to Fill Backlog
- Early Projects Develop Cash Flow Early in Year – Good for Contractors

Project Staff

Who is Project Leader / Supervisors
- Will Disputes Be Resolved ?
- Will Quantities Be Measured and Paid Fairly ?
- Will Extra Work Be Paid Properly Without Dispute ?
- Will CRI's be Accepted ?
- Will Materials Penalties and Non-Conforming Work be Handled Reasonably ?
- Will Project Be a Headache to Manage ?

Additional Considerations

Historic Unit Prices Not Enough

- Consider Recent Risk Developments
- Specification Changes
- "Fancy Stuff" is expensive

Scheduling is Biggest Factor – Labor Costs and Risk

Commodity Prices can be Volatile and Very Difficult to Predict or Nail Down

Strongly Consider Addenda Requests and Constructability Review Comments

Important Earthwork Plan Considerations

- Major Earthwork Bid Items
- Earthwork Tables
- Measurement and Payment Methods
- New Technology

Major Earthwork Bid Items

- Pavement Removal
- Common Excavation
- Borrow Excavation
- Marsh Excavation
- Aggregates
- MSE Walls
- Topsoil / Salvaged
- Storm Sewer Removal
- Water
- Erosion Control Items

Pavement Removal

Item Includes:

- Mill or Remove Asphalt Overlay
- Break Concrete Pavement
- Remove Concrete Pavement
- Separate Steel Reinforcing if Necessary
- Trucking for Export or Stockpile for Recycling

Special Considerations

- Volume of Pavement in Cut Areas also Measured as Common Excavation
- Volume of Pavement in Fills not Measured as Common Excavation
- Remember to Include Sawcutting Item Between Stages

Common Excavation

Item Includes:

- Asphalt Pavement Removal
- Excess Topsoil Removal
- Cut and Fill (Including Compaction)
- Export
- Excavation Below Subgrade
- Finish Grading of Subgrade
- Backfilling Curbs
- QMP Subgrade if Specified
- Placement and Compaction of Spoils from Structure and Storm Sewer used as Fill

Special Considerations

- Material Moved Between Stages Must Be Paid as Common Excavation – May require Double Handling
- Volume of Pavement in Cut Areas Paid as Common Excavation
- Excess Soil Can Be Placed Outside Design Slopes if Possible
- Special Compaction Incidental to Common Excavation
- Seeding, Fertilizer, Mulching of Dedicated Disposal Sites Paid Under Separate Bid Items

Borrow Excavation

Item Includes:

- Cost to Obtain Borrow Material
- Clearing and Grubbing at Borrow Site
- Topsoil Stripping and Respread at Borrow Site
- Load, Haul, Place and Compact Borrow Material
- Shaping and Grading for Borrow Area Restoration

Special Considerations

- Default Payment Based on Measurement at Borrow Site
- Erosion Control, Seeding and Fertilizer Paid Separately Under Contract Bid Items
- Water for Dust Control and Compaction Paid Separately Under Water Bid Item
- Contractor Responsible for Haul Road Maintenance and Restoration

Marsh Excavation

Item Includes:

- Excavate Wet Marsh Through Water to Firm Foundation
- Excavate Dry Marsh
- Load, Haul and Grade Marsh Material at Disposal Area

Special Considerations

- Marsh Material May Be Placed Outside of Design Slopes Where Possible
- Very Difficult and Messy to Haul Wet Marsh Material

Aggregate Base / Select Crushed / Breaker Run

Item Includes:

- Cost to Provide Delivered Aggregate from Off Site Sources
- Cost to Crush Concrete and Asphalt Rubble Generated On Site
- Cost to Load and Haul Recycled Material On Site
- Placement and Compaction of Aggregates
- Aggregate Base for Temporary Access
- Aggregate Base for Small Areas like Sidewalks, Driveways, Islands
- Finish Grading Surface Prior to Pavement Installation
- QMP Base Aggregate (No QMP for Select or Breaker)

Special Considerations

- Areas to Recycle Site Generated Aggregate are Often Hard to Make Happen
- Water for Dust Control and Compaction Paid Separately Under Water Bid Item
- Special Compaction Incidental (2014 Trial Projects)

MSE Walls (Mechanically Stabilized Earth)

Item Includes:

- Usually Excavation for MSE Wall is Incidental to Bid Item
- Concrete Footing Beneath Panels
- Furnish and Install Concrete Panels
- Install Reinforcement Straps, Geotextile Between Seams
- Granular Backfill
- Coping Sometimes Incidental to Bid Item
- QMP Wall (Very Intensive Testing of Backfill Material, Compaction Testing, Inspection)

Special Considerations

- Testing of Backfill Material Must be Done During Manufacturing Process to Meet Schedule
- Staging / Scheduling of Mural Type Panels Very Challenging

Salvaged Topsoil / Topsoil

Item Includes:

- Stripping and Stockpiling Topsoil (Salvaged Topsoil Item)
- Cost of Obtaining Suitable off Site Topsoil (Topsoil Item)
- Undercutting Excavations and Underfilling Embankments Necessary to Receive Topsoil
- Placement and Finish Grading of Topsoil

Miscellaneous Bid Items

Storm Sewer Removal

On Large Projects With Extensive Removals, Include Bid Item for Granular Backfill or Provide Depth of Storm Sewer to Be Removed

Water Item (Often Forgotten in Some WDOT Regions)

- Dust Control
- Compaction

Earthwork Tables

- Earthwork Tables Must Balance (i.e., Total Cut = Expanded Fill + Export + Recycled Pavement)
- Should Be as Simple as Possible
- Stage Movements / Payment (If Double Handling Required, Measured and Paid Each Time)
- Accurate Shrinkage / Swell Factors (Can Greatly Affect Borrow / Export Quantities)
- Conversion Factors for Aggregates
- Undistributed Quantities Can Have a Significant Impact on Unit Prices
- Temporary Alignments Must Be Included in Quantities and Earth Flows

(Examples of Inconsistencies in this)

EARTHWORK

Included Structure Excavation quantities. Storm sewer spoils?

CATEGORY	STAGE	LOCATION	STATION - STATION	205.0100 EXCAVATION COMMON (1) CUT (2) CY	205.0100 EXCAVATION COMMON (1) EBS EXCAVATION (3) 5% OF CUT CY	SALVAGED/UNUSABLE PAVEMENT MATERIAL CY	STRUCTURE EXCAVATION (4) CY	AVAILABLE MATERIAL (5) CY	REDUCED EBS IN FILL (6) FACTOR 0.8 CY	EXPANDED EBS BACKFILL (7) FACTOR 1.25 CY	UNEXPANDED FILL CY	EXPANDED FILL (8) FACTOR 1.25 CY	MASS ORDINATE +/- (9)	WASTE (10) CY	* 312.0110 SELECT CRUSHED MATERIAL (11) TON
0010	STAGE 4	MAINLINE	1080+03 - 1125+13	11,336	567	1,136	0	10,200	454	709	0	0	10,200	11,790	1,241
		D RAMP	131+73 D - 138+23 D	990	50	0	0	990	40	63	512	640	350	390	110
		PARKING LOT	132+37 D - 135+40 D	266	13	36	0	230	10	16	8	10	220	266	28
		TEMP PAVEMENT & CROSSOVER REMOVAL	---	9,500	475	0	0	9,500	380	594	0	0	9,500	9,880	1,040
		LIGHT BOX	---	63	0	0	0	63	0	0	18	23	40	40	0
		MAINLINE	UNDISTRIBUTED	0	600	0	0	0	480	750	0	0	0	480	1,313
			SUBTOTALS (STAGE 4)	22,255	1,705	1,172	0	20,983	1,364	2,132	538	673	20,310	22,846	3,732
	STAGE 5	MAINLINE	1080+17 - 1177+20	52,189	2,609	11,890	2,947	43,246	2,087	3,261	25,930	32,488	10,758	24,735	5,707
		A RAMP	128+92 A - 143+38 A	5,656	283	899	0	4,757	226	354	137	171	4,586	5,711	620
		B RAMP	143+78 B - 158+02 B	2,599	130	0	0	2,599	104	163	2,575	3,219	-620	-515	285
		E RAMP	140+00 E - 143+04 E	1,111	56	0	0	1,111	45	70	44	55	1,056	1,101	123
		F RAMP	144+75 F - 146+85 F	456	23	0	0	456	18	29	207	259	197	215	51
		J RAMP	92+40 J - 95+95 J	988	49	334	0	654	39	61	36	45	609	982	107
		M RAMP	12+03 M - 13+10 M	42	2	0	0	42	2	3	145	181	-139	-137	5
		PEDESTRIAN UNDERPASS	6+22 PA - 6+84 PA	20	1	0	0	20	1	1	0	0	20	21	2
		WEST BELTLINE FRONTAGE ROAD	126+00 EE - 136+73 EE	2,804	140	127	0	2,677	112	175	3	4	2,673	2,912	306
		WEST BELTLINE FRONTAGE ROAD	137+61 EE - 142+60 EE	285	14	30	0	255	11	18	3	4	251	292	32
		BRITTA PARKWAY	22+26 BP - 23+07 BP	138	7	0	0	138	6	9	0	0	138	144	15
		WHENONA DRIVE	10+50 WD - 11+25 WD	198	10	9	0	189	8	13	2	3	186	203	23
		M RAMP	1+13 M - 4+13 M	261	13	0	36	297	10	16	1,769	2,211	-1,914	-1,904	28
		N RAMP	0+76 N - 4+28 N	29	1	0	0	29	1	1	4,508	5,635	-5,606	-5,605	2
		TEMP PAVEMENT & CROSSOVER REMOVAL	---	2,670	134	0	0	2,670	107	168	0	0	2,670	2,777	294
		MAINLINE	UNDISTRIBUTED	0	1,200	0	0	0	960	1,500	0	0	0	960	2,625
			SUBTOTALS (STAGE 5)	69,446	4,672	13,289	2,983	59,140	3,737	5,842	35,419	44,275	14,865	31,891	10,226
	STAGE 6	MAINLINE	1062+46 - 1180+50	57,203	3,360	10,181	8,707	55,729	2,688	4,200	17,756	22,195	43,534	56,403	7,350
		VERONA ROAD/MIDVALE BOULEVARD	998+22 VR - 1012+81 VR	26,431	1,322	2,908	507	24,030	1,058	1,653	1,077	1,346	22,684	25,650	2,893
		C RAMP	145+21 C - 157+82 C	13,497	675	1,315	0	12,182	540	844	392	490	11,692	13,547	1,477
		D RAMP	127+51 D - 143+64 D	6,152	308	175	0	5,977	246	385	187	234	5,743	6,154	674
		G RAMP	145+84 G - 148+30 G	1,589	79	0	0	1,589	63	99	28	35	1,554	1,617	173
		H RAMP	100+87 H - 102+08 H	460	23	0	0	460	18	29	10	13	447	465	51
		K RAMP	78+70 K - 89+70 K	3,387	199	1,170	0	2,817	159	249	44	55	2,762	4,031	436
		HANMERSLEY ROAD	96+85 HM - 99+60 HM	1,434	72	0	0	1,434	58	90	47	59	1,375	1,433	158
		NAKOMA ROAD	10+47 NA - 14+00 NA	2,395	120	0	0	2,395	96	150	67	84	2,311	2,407	263
		TEMP PAVEMENT & CROSSOVER REMOVAL	---	4,870	244	0	0	4,870	195	305	0	0	4,870	5,065	534
		MAINLINE	UNDISTRIBUTED	0	750	0	0	0	600	938	0	0	0	600	1,642
			SUBTOTALS (STAGE 6)	128,018	7,152	15,749	9,214	121,483	5,721	8,942	19,608	24,511	96,972	118,442	15,651
			TOTALS	219,619	13,529	30,210	12,197	201,606	10,822	16,916	55,565	69,459	132,147	173,179	29,609
			ITEM TOTAL		233,148										

1) EXCAVATION COMMON IS THE SUM OF THE CUT AND EBS EXCAVATION COLUMNS. ITEM NUMBER 205.0100.
2) SALVAGED/UNUSABLE PAVEMENT MATERIAL IS INCLUDED IN CUT.
3) EBS EXCAVATION IS AN UNDISTRIBUTED QUANTITY AND IS TO BE BACKFILLED WITH SELECT CRUSHED MATERIAL.
4) STRUCTURE EXCAVATION IS FOR INFORMATION ONLY. SEE CONSTRUCTION DETAILS FOR ANTICIPATED LIMITS. LIMITS WILL VARY DEPENDING ON SHOP DRAWING DESIGN.
   STRUCTURE BACKFILL VOLUMES ARE NOT INCLUDED IN FILL VOLUMES. STRUCTURE EXCAVATION IS INCIDENTAL TO BID ITEM "WALL CONCRETE PANEL MECHANICALLY STABILIZED EARTH LRFD".
5) AVAILABLE MATERIAL = CUT + STRUCTURE EXCAVATION - SALVAGED/UNUSABLE PAVEMENT MATERIAL.
6) REDUCED EBS IN FILL: EXCAVATED EBS MATERIAL IS USABLE IN FILLS OUTSIDE THE 1:1 SLOPE. EBS IN FILL REDUCTION FACTOR = 0.8.
7) EXPANDED EBS BACKFILL: THIS IS TO BE FILLED WITH SELECT CRUSHED MATERIAL. EBS BACKFILL EXPANSION FACTOR = 1.25.
8) EXPANDED FILL = UNEXPANDED FILL * EXPANDED FILL FACTOR. EXPANDED FILL FACTOR = 1.25.
9) MASS ORDINATE = AVAILABLE MATERIAL - EXPANDED FILL . PLUS MASS ORDINATE QUANTITY INDICATES AN EXCESS OF MATERIAL WITHIN THE DIVISION. MINUS MASS ORDINATE QUANTITY INDICATES A SHORTAGE OF MATERIAL WITHIN THE DIVISION.
10) WASTE = MASS ORDINATE + SALVAGED/UNUSABLE PAVEMENT MATERIAL + REDUCED EBS IN FILL.
11) SELECT CRUSHED MATERIAL IS USED FOR BACKFILL OF EBS.

* ADDITIONAL QUANTITIES LISTED ELSEWHERE

Include temporary alignments - GOOD!

Undistributed quantities have potential to create problems.

Expanded Fill Factor probably too high.

Consider Breaker Run for EBS backfill unless there are drainage considerations.

Expanded Fill	69,459 CY
Mass Ordinate	132,147 CY
Total	201,606 CY
Equals Available Material quantity - GOOD!	

29609 TN/13529 CY = 2.19 TN/CY
Conversion rate too high for Select Crushed.

Example of Bid Uncertainty
Blended Unit Price – Common Excavation
Fill Factor Reduction

Fill Factor	1.25				
Cut & Fill - 100' to 500'	25000	CY	$3.25	$81,250.00	
Cut & Fill - 1000' to 1500'	40000	CY	$4.00	$160,000.00	
Cut & Fill - On Road Truck	10000	CY	$10.00	$100,000.00	
Cut & Export	50000	CY	$14.00	$700,000.00	
EBS - Export	2500	CY	$15.00	$37,500.00	
Total				$1,078,750.00	
Common Excavation Quantity				127,500	CY
Common Excavation Bid Unit Price				$8.46	/CY

Fill Factor	1.10				
Cut & Fill - 100' to 500'	22000	CY	$3.25	$71,500.00	
Cut & Fill - 1000' to 1500'	35200	CY	$4.00	$140,800.00	
Cut & Fill - On Road Truck	8800	CY	$10.00	$88,000.00	
Cut & Export	59000	CY	$14.00	$826,000.00	
EBS - Export	2500	CY	$15.00	$37,500.00	
Total				$1,163,800.00	
Common Excavation Quantity				127,500	CY
Common Excavation Revised Unit Price				$9.13	/CY
Difference				$0.67	/CY
Total Deficiency	127,500	CY	$0.67	**($85,050.00)**	**-7.88%**

Example of Bid Uncertainty
Blended Unit Price – Common Excavation
EBS Increase

Fill Factor	1.25			
Cut & Fill - 100' to 500'	25000	CY	$3.25	$81,250.00
Cut & Fill - 1000' to 1500'	40000	CY	$4.00	$160,000.00
Cut & Fill - On Road Truck	10000	CY	$10.00	$100,000.00
Cut & Export	50000	CY	$14.00	$700,000.00
EBS - Export	2500	CY	$15.00	$37,500.00
Total				$1,078,750.00
Common Excavation Quantity				127,500 CY
Common Excavation Bid Unit Price				$8.46 /CY
Actual Cost for Increased EBS	17500	CY	$15.00	$262,500.00
Additional Payment for EBS at Common Exc Unit Price	17500	CY	$8.46	$148,050.00
Difference				($114,450.00)

Fill Factor	1.25			
Cut & Fill - 100' to 500'	25000	CY	$3.25	$81,250.00
Cut & Fill - 1000' to 1500'	40000	CY	$4.00	$160,000.00
Cut & Fill - On Road Truck	10000	CY	$10.00	$100,000.00
Cut & Export	50000	CY	$14.00	$700,000.00
EBS - Export	20000	CY	$15.00	$300,000.00
Total				$1,341,250.00
Common Excavation Quantity				145,000 CY
Common Excavation Unit Price				$8.46 /CY

Measurement and Payment

- Temporary Fills / Cuts for Staged Areas
- Sloped Areas
- Pay Plan Quantity
- Incidental Items
- ASP-5 – Fuel Cost Adjustment
- Contract Mods – Section 104

New Technologies

- Three Dimensional Models
- GPS Machine Control
- Lidar Survey Capabilities
- Aerial Survey (UAV – Unmanned Aerial Vehicle)
- SPAR Utility Location

How Can the Construction Industry Help ?

WTBA is Willing to Work with WisDOT / Consultant Design Teams

- Accurate Estimates Are Important to Industry Also
- Bidding Information Is Proprietary
- Anti-Trust Concerns

Questions ?

WisDOT design teams who seek WTBA input need to contact their region.

WTBA
WISCONSIN TRANSPORTATION BUILDERS ASSOCIATION