



# Using Formulas in CES<sup>®</sup>

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Trns•port User's Group  
November 2002



# Formulas in CES

- Available for all numeric fields with 5.1a
  - Identified by color of field label
- Provide the capability to perform automatic calculations within CES
- Support standard algebraic expressions and basic functions
  - Addition, subtraction, multiplication, etc.
  - Absolute value, Rounding, Truncation, etc.
  - Conditional (If, then, else)



# Formulas in CES

- Support the use of standard job columns and also variables created by the Estimator
  - For example, use the length and pavement width to calculate lane miles for a job
- Formula Libraries are available to provide a way to store/catalog formulas



# Examples

- Simple conversions
  - Example, converting 8 inches to feet
    - $8 / 12$
  - Preserves the value of 8" converted to feet rather than just entering .667

# Examples

- Calculating Lane Miles
  - Using Length (miles) and Width (feet) from job and a lane as a constant 12 feet wide
  - # of lanes =  $\text{Width} / 12$
  - Lane Miles =  $\text{Length} * \# \text{ of lanes}$
  - Formula is:  $\text{Length} * \text{Width} / 12$
- Can add a variable to store the value of lane width
  - Formula is:  $\text{Length} * \text{Width} / \text{LaneWidth}$



# CES Job

**Job 45000**

General | Variables | Cost Groups | Categories | Items | Programs | Funding | Attachments

page 1 | page 2

Job Number: 45000      Spec Year: 88      Unit System: E

Description 1: MILLING AND OVERLAY  
Description 2:

| Classifications    | Inflation                | Fed/State Project Num.: |
|--------------------|--------------------------|-------------------------|
| Work Type: RSFB    | Inflation %: 0.0000      | 3528-0011               |
| Highway Type: ASPH | Years Until Work: 0.0000 | C&E %:                  |
| Job Type:          | Base Date: 01/01/2002    |                         |

| Location       | Bid Histories                                       | Estimated By: JRK           |
|----------------|---|-----------------------------|
| County: C032   | Cost Grp Hist: ↓                                    | Date Created: 10/17/2002    |
| Urban/Rural: R | Item History: MN-SY88-96-00 ↓                       | Last Updated: 10/17/2002    |
| District: 7 ↓  | Bid-based: <input type="radio"/> Use Model          | Conceptual Estimate: 0.0000 |
| Begin Termini: | Inflation: <input checked="" type="radio"/> Use Job |                             |
| End Termini:   | Season: SUMM  |                             |

| Metrics                 | Cost Sheets                                       | Estimate: 3,295,266.01      |
|-------------------------|---|-----------------------------|
| Depth (in/mm): 5.0000   | Davis-Bacon?: <input checked="" type="checkbox"/> | Contingency Percent: 1.0000 |
| Length (Mi/km): 18.0000 | Labor Cls.: WEST                                  | Total: 3,328,218.67         |
| Width (ft/m): 24.0000   | Eqpmt Cls.: DEF                                   |                             |
| Lane Mi/km:             | Materials Cls.: DEF                               |                             |





# Calculating Lane Miles

Job 45000

General | Variables | Cost Groups | Categories | Items | Programs | Funding | Attachments

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Job Number: 45000      Spec Year: 88      Unit System: E

Description 1: MILLING AND OVERLAY

Description 2:

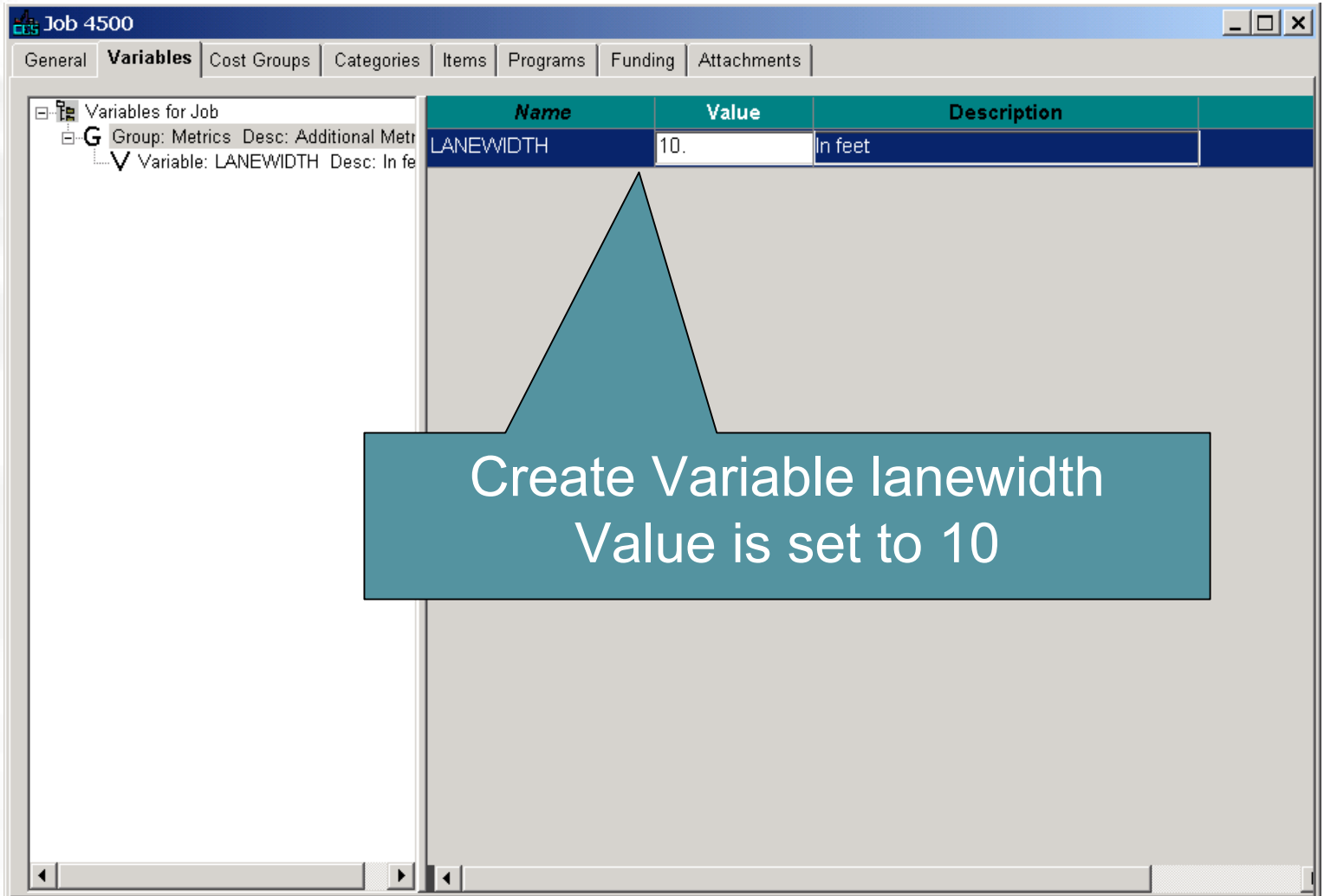
| Classifications |      | Inflation         |            | Fed/State Project Num.: |  |
|-----------------|------|-------------------|------------|-------------------------|--|
| Work Type:      | RSFB | Inflation %:      | 0.0000     | 3528-0011               |  |
| Highway Type:   | ASPH | Years Until Work: | 0.0000     | C&E %:                  |  |
| Job Type:       |      | Base Date:        | 01/01/2002 |                         |  |

| Local          |      | Conceptual Estimate: |  |
|----------------|------|----------------------|--|
| County:        | C032 | 0.0000               |  |
| Urban/Rural:   | R    | Estimate:            |  |
| District:      | 7    |                      |  |
| Begin Termini: |      |                      |  |
| End Termini:   |      |                      |  |

| Metrics         |         | Cost Sheets          |              | Estimate: |  |
|-----------------|---------|----------------------|--------------|-----------|--|
| Depth (in/mm):  | 5.0000  | Estimate:            | 3,295,266.01 |           |  |
| Length (Mi/km): | 18.0000 | Contingency Percent: | 1.0000       |           |  |
| Width (ft/m):   | 24.0000 | Total:               | 3,328,218.67 |           |  |
| Lane Mi/km:     | 36.0000 |                      |              |           |  |

Result:  
36 Lane Miles

# Using LaneWidth Variable



Job 4500

General **Variables** Cost Groups Categories Items Programs Funding Attachments

Variables for Job

- Group: Metrics Desc: Additional Metr
- Variable: LANEWIDTH Desc: In fe

| Name      | Value | Description |
|-----------|-------|-------------|
| LANEWIDTH | 10.   | In feet     |

Create Variable lanewidth  
Value is set to 10



# Using LaneWidth Variable

Job 4500

General | Variables | Cost Groups | Categories | Items | Programs | Funding | Attachments

page 1 | page 2

Job Number: 4500      Spec Year: 88      Unit System: E

Description 1: MILLING AND OVERLAY

Description 2:

| Classifications    | Inflation                | Fed/State Project Num.: |
|--------------------|--------------------------|-------------------------|
| Work Type: RSFB    | Inflation %: 0.0000      | 3528-0011               |
| Highway Type: ASPH | Years Until Work: 0.0000 | C&E %:                  |
| Job Type:          | Base Date: 01/01/2002    |                         |

| Location       | Estimate: |
|----------------|-----------|
| County: C032   |           |
| Urban/Rural: R |           |
| District: 7    |           |
| Begin Termini: |           |
| End Termini:   |           |

| Metrics                     | Cost Sheets                 | Estimate: |
|-----------------------------|-----------------------------|-----------|
| Depth (in/mm): 5.0000       | Estimate: 0.00              |           |
| Length (Mi/km): 18.0000     | Contingency Percent: 1.0000 |           |
| Width (ft/m): 24.0000       | Total: 0.00                 |           |
| Lane Mi/km: width/lanewidth |                             |           |

Replace 12 with variable: / lanewidth



# Using LaneWidth Variable

Job 4500

General Variables Cost Groups Categories Items Programs Funding Attachments

page 1 page 2

Job Number: 4500 Spec Year: 88 Unit System: E

Description 1: MILLING AND OVERLAY

Description 2:

**Classifications**

Work Type: RSFB  
Highway Type: ASPH  
Job Type:

**Inflation**

Inflation %: 0.0000  
Years Until Work: 0.0000  
Base Date: 01/01/2002

Fed/State Project Num.: 3528-0011  
C&E %:

**Location**

County: C032  
Urban/Rural: R  
District: 7  
Begin Termini:  
End Termini:

**Metrics**

Depth (in/mm): 5.0000  
Length (Mi/km): 18.0000  
Width (ft/m): 24.0000  
Lane Mi/km: 43.2000

**Cost Sheets**

Estimate: 0.00  
Contingency Percent: 1.0000  
Total: 0.00

**Result:**  
43.2 Lane Miles



# Formulas

- Improved expression builder
  - Opens with double click or menu choice
  - Optional description
  - Improved display and selection for format libraries and functions/columns
  - Displays result once validated
  - Includes status message
- Formula trace
  - Shows in what formulas a field is used



# Expression Builder

Job 45000

General Variables

page 1 page 2

Job Num  
Descripti  
Descripti

Work Ty  
Highway Ty  
Job Ty

Cou.  
Urban/Ru  
Dist  
Begin Term  
End Term

Depth (in/m)  
Length (Mi/k  
Width (ft/  
Lane Mi/k

### Formula and Expression Builder

Description:  Result: 36

Expression:

Select To Add To Expression

Library: sample

| Name        | Express                    |
|-------------|----------------------------|
| CYofCompAgg | (JOBPAVEMENTWIDTH*JOBLENGT |
| SYofMilling | JOBPAVEMENTWIDTH*JOBLENGTH |
| TonsOfBit   | (JOBPAVEMENTWIDTH*JOBLENGT |

Columns/Functions:

- Arithmetic/Truncation
- Arithmetic/Truncation
- Character/String
- Conditional
- Mathematical/Trigonometric
- Simple Statistics
- Job Columns**
- Job Variables

Status

Status: \*OK Description: Valid Expression

Message: Valid Expression

OK Validate Cancel



# Formulas for quantity

- @QUANTITY Variable
  - automatically puts the formula in the quantity when the cost group or item is brought into a job
- Milling Cost Group in Sq Yd
  - Using Length (miles) and Width (feet)
    - Length in Feet = Length \* 5280
    - Square Feet = Length in Feet \* Width
    - Square Yards = Square Feet / 9
    - Formula is:  $\text{Length} * 5280 * \text{Width} / 9$



# Add @QUANTITY to Cost Group

**Cost Group List**

| Cost Group ID | Spec Year | Description    | Unit | Calculation Rule |
|---------------|-----------|----------------|------|------------------|
| AGG           | 88        | AGGREGATE BASE | C Y  | NORM             |
| BIT           | 88        | BITUMINOUS     | TON  | NORM             |
| BRID          |           |                |      |                  |
| CEX           |           |                |      |                  |
| CG            |           |                |      |                  |
| CPV           |           |                |      |                  |
| DS            |           |                |      |                  |
| GDRL          |           |                |      |                  |
| <b>MILL</b>   |           |                |      |                  |
| MISC          |           |                |      |                  |
| MOB           |           |                |      |                  |

**Cost Group BIT Spec Year 88**

General **Variables** Items Attachments

| Name      | Value  |
|-----------|--|
| @QUANTITY | $(\text{JOBPAVEMENTWIDTH} * \text{JOBLENGTH} * 5280 / 9 * 110 * \text{JOBPAVEMENTDEPTH}) / 20$ |

**Cost Group MILL Spec Year 88**

General **Variables** Items Attachments

| Name      | Value   |
|-----------|---|
| @QUANTITY | $\text{JOBPAVEMENTWIDTH} * \text{JOBLENGTH} * 5280 / 9$ |



# CES Job

**Job 45000**

General | Variables | Cost Groups | Categories | Items | Programs | Funding | Attachments

page 1 | page 2

Job Number: 45000      Spec Year: 88      Unit System: E

Description 1: MILLING AND OVERLAY  
Description 2:

| Classifications    | Inflation                | Fed/State Project Num.: |
|--------------------|--------------------------|-------------------------|
| Work Type: RSFB    | Inflation %: 0.0000      | 3528-0011               |
| Highway Type: ASPH | Years Until Work: 0.0000 | C&E %:                  |
| Job Type:          | Base Date: 01/01/2002    |                         |

| Location       | Bid Histories                                       | Estimated By: JRK           |
|----------------|---|-----------------------------|
| County: C032   | Cost Grp Hist: ↓                                    | Date Created: 10/17/2002    |
| Urban/Rural: R | Item History: MN-SY88-96-00 ↓                       | Last Updated: 10/17/2002    |
| District: 7 ↓  | Bid-based: <input type="radio"/> Use Model          | Conceptual Estimate: 0.0000 |
| Begin Termini: | Inflation: <input checked="" type="radio"/> Use Job |                             |
| End Termini:   | Season: SUMM  |                             |

| Metrics                 | Cost Sheets                                       | Estimate: 3,295,266.01      |
|-------------------------|---|-----------------------------|
| Depth (in/mm): 5.0000   | Davis-Bacon?: <input checked="" type="checkbox"/> | Contingency Percent: 1.0000 |
| Length (Mi/km): 18.0000 | Labor Cls.: WEST                                  | Total: 3,328,218.67         |
| Width (ft/m): 24.0000   | Eqpmt Cls.: DEF                                   |                             |
| Lane Mi/km: 36.0000     | Materials Cls.: DEF                               |                             |



# Cost groups with @QUANTITY

Job 46000

General Variables **Cost Groups** Categories Items Programs Funding Attachments

Find Line Number:  Filter: <Show All>

| Line Number | Cost Group ID | Description | Unit | Calculation Rule | Quantity | Price | Extended Amount |
|-------------|---------------|-------------|------|------------------|----------|-------|-----------------|
| 00000001    |               |             |      |                  |          |       |                 |
| 00000002    |               |             |      |                  |          |       |                 |

**Cost Groups for Spec Year 88, Work Type RSFB**

| Percentage | Cost Group ID | Description                      | Calculation |
|------------|---------------|----------------------------------|-------------|
| 53.25      | BIT           | BITUMINOUS                       | NORM        |
| 10.17      | CEX           | COMMON EXCAVATION                | NORM        |
| 3.50       | BRID          | BRIDGE                           | NORM        |
| 3.46       | MOB           | MOBILIZATION                     | PCT         |
| 2.99       | TRAF          | TRAFFIC CONTROL                  | PCT         |
| 2.93       | TSSM          | TRAFFIC SIGN, SIGNAL, MANAGEMENT | NORM        |
| 2.92       | RCP           | RC PIPE                          | NORM        |

OK Filter Sort Cancel Help Ranking Library: Asphalt

0.00



# Cost groups with @QUANTITY

Job 46000

General Variables **Cost Groups** Categories Items Programs Funding Attachments

Find Line Number:  Filter: <Show All>

| Line Number | Cost Group ID | Description               | Unit | Calculation Rule | Quantity     | Price | Extended Amount |
|-------------|---------------|---------------------------|------|------------------|--------------|-------|-----------------|
| 00000001    | BIT           | BITUMINOUS                | TON  | NORM             | 69,696.0000  |       |                 |
| 00000002    | MILL          | MILLING BITUMINOUS SURFAC | SY   | NORM             | 253,440.0000 |       |                 |

**Formula and Expression Builder**

Description:  Result: 253440

Expression:

Select To Add To Expression

Library: sample

| Name        | Express                    |
|-------------|----------------------------|
| CYofCompAgg | (JOBPAVEMENTWIDTH*JOBLENGT |
| SYofMilling | JOBPAVEMENTWIDTH*JOBLENGTH |
| TonsOfBit   | (JOBPAVEMENTWIDTH*JOBLENGT |

Columns/Functions: Arithmetic/Truncation

- abs(n) Absolute value of
- ceiling(n) Smallest whole nu
- int(n) Largest whole nu
- mod(x,y) Remainder of divi
- round(x,y) Returns x rounde
- sign(n) Returns -1,0,1 ba

Status

Status: \*OK Description: Valid Expression

0.00



# Related New Features in CES

- Ad Hoc price can now be entered from the grid view
  - Automatically creates a new Ad Hoc reference price task
  - Deactivates all task currently associated with the item
  - Formulas only on the tree view



# Adhoc Price

Job 5202

General Variables Cost Groups Categories **Items** Programs Funding Attachments

| Line Number | Item          | Description                       | Units | LS Units | Quantity   | Unit Price  | Extended Amount | Alt. Co |
|-------------|---------------|-----------------------------------|-------|----------|------------|-------------|-----------------|---------|
| 0004        | 2021501/00010 | MOBILIZATION                      | LS    |          | 1.0000     | 8,409.04908 | 8,409.05        |         |
| 0005        | 2563601/00010 | TRAFFIC CONTROL                   | LS    |          | 1.0000     | 1600        | 18,094.00       |         |
| 0010        | 2105525/00030 | TOPSOIL BORROW (CV)               | C Y   |          | 370.0000   | 16.31065    | 6,034.94        |         |
| 0015        | 2340508/00030 | TYPE 31 WEARING COURSE MIXTURE    | TON   |          | 7,900.0000 | 11.39868    | 90,049.57       |         |
| 0020        | 2340512/00030 | TYPE 31 LEVELING COURSE MIXTURE   | TON   |          | 7,900.0000 | 11.35688    | 89,719.35       |         |
| 0025        | 2357502/00010 | BITUMINOUS MATERIAL FOR TACK COAT | GAL   |          | 5,700.0000 | 0.78326     | 4,464.58        |         |
| 0030        | 2575502/00080 | SEED MIXTURE 80                   | LB    |          | 100.0000   | 1.92319     | 192.32          |         |
| 0035        | 2580501/00010 | TEMPORARY LANE MARKING            | RDST  |          | 530.0000   | 3.15371     | 1,671.47        |         |

Enter new price of \$1,600 directly from grid view

218,635.28



# Adhoc Price

Job 5202

General Variables Cost Groups Categories **Items** Programs Funding Attachments

Items for Job 5202

- Line: 0004 Item: 2021501/00010 Desc: MOBILIZATION
  - Task ID: REF 001 Comment: Percent of total
- Line: 0005 Item: 2563601/00010 Desc: TRAFFIC CONTROL
  - Task ID: REF 001 Comment: Historical Reference Price
  - Task ID: REF 002 Comment: Adhoc Reference Price
- Line: 0010 Item: 2105525/00030 Desc: TOPSOIL BORROW (CV)
  - Task ID: BID BASED Comment: Regression model 1
- Line: 0015 Item: 2340508/00030 Desc: TYPE 31 WEARING SURFACE
  - Task ID: 03W8 Group Name: 18000+ T/RATE=30
  - Task ID: B3PRAGGB-4 Cost Sheet ID: B3PRAGGB
  - Task ID: B3WPR300-2 Cost Sheet ID: B3WPR300
  - Task ID: BITPL300-2 Cost Sheet ID: BITPL300
  - Task ID: TH23T300-2 Cost Sheet ID: TH23T300
- Line: 0020 Item: 2340512/00030 Desc: TYPE 31 WEARING SURFACE
  - Task ID: 03L7 Group Name: 5001-180
  - Task ID: B3APR200-1 Cost Sheet ID: B3APR200
  - Task ID: B3PRAGGB-1 Cost Sheet ID: B3PRAGGB
  - Task ID: BITPL200-1 Cost Sheet ID: BITPL200
  - Task ID: TH23T200-1 Cost Sheet ID: TH23T200
- Line: 0025 Item: 2357502/00010 Desc: BLENDED ASPHALT
  - Task ID: BID BASED Comment: Regression model 1
- Line: 0030 Item: 2575502/00080 Desc: SEED MIXTURE 80
  - Task ID: BID BASED Comment: Regression model 1
- Line: 0035 Item: 2580501/00010 Desc: TEMPORARY LANE MARKING
  - Task ID: BID BASED Comment: Regression model 3

Job Number: [ ] Spec Year: [ ] Inflation Type: [ ] Bid-Base: [ ]

|                            |            |                          |                   |
|----------------------------|------------|--------------------------|-------------------|
| Inflation:                 | 0.00       | Inflation:               | 0.00              |
| Non Bid-Based Tasks:       | 181,368.92 | Non Bid-Based Tasks:     | 0.00              |
| Inflation:                 | 0.00       | Inflation:               | 0.00              |
| Item Sub-Total:            | 193,732.23 | Cost Group Sub-Total:    | 0.00              |
|                            |            | Percent Tasks:           | 0.00              |
|                            |            | Estimate Group Estimate: | 0.00              |
|                            |            |                          | 201,481.52        |
|                            |            |                          | 0.00              |
| <b>Total Job Estimate:</b> |            |                          | <b>201,481.52</b> |

Existing Reference Price task set to inactive

Adhoc Reference Price task added



# Related New Features in CES

- Item price can be based on a percent of the total job cost
  - Percent can also be calculated using a formula
- New price breakdown panel included
  - Displays subtotals for primary components



# Item price based on percent

Trns-port CES

File Edit View Utilities Window Help

Job CFA116295-COPY

General Variables Cost Groups Categories **Items** Programs Funding Attachments

| Line | Item      | Desc                      |
|------|-----------|---------------------------|
| 0176 | 503E21320 | UNCL EXCAVATION, INCL F   |
| 0177 | 516E13200 | 1/2" PREF EXP JT FILLER   |
| 0178 | 516E13900 | 2" PREFORMED EXP JT F     |
| 0179 | 516E14021 | SEMI-INTEGRAL ABUT EXP    |
| 0180 | 516E44101 | BRG/INT LAM/PLATE,APP     |
| 0181 | 516E44101 | BRG/INT LAM/PLATE,APP     |
| 0182 | 518E21231 | POROUS BACKFILL WITH      |
| 0183 | 518E40000 | 6" PERF CORR. PLASTIC F   |
| 0184 | 518E40010 | 6" NON-PERF CORR PLAS     |
| 0185 | 524E94704 | DRILLED SHAFTS, 36" INT   |
| 0186 | 601E20000 | CR AGG SLOPE PROT         |
| 0195 | 865E16000 | PRESTRESSED CONC BRI      |
| 0196 | 865E20000 | PRESTRESSED CONC BRI      |
| 0197 | 610E13600 | REIN EARTH WALL           |
| 0198 | 610E13800 | RETAINED EARTH WALL       |
| 0199 | 103E05000 | CONTRACT PERFORMANCE BOND |
| 0200 | 614E11000 | MAINTAINING TRAFFIC       |
| 0201 | 623E10000 | CONSTRUCTION LAYOUT S     |
| 0202 | 624E10000 | MOBILIZATION              |
| 0203 | 806E16020 | FIELD OFFICE, TYPE C      |
| 0204 | 610E14200 | MSE PLUS RETAINING WA     |

Item: 103E05000 Description: CONTRACT PERFORMANCE BOND  
Units: LS LS Units: Supp. Proposal Desc.:  
Quantity: 1.000 Unit Price: 146,215.05258 Extended Amount: 146,  
Task ID: REF 003  
Comment: Use if over 5 million

Calculation Rule

- Normal
- Percent on Top

Price:  
Percent: 1.00

Ready

Has three choices for pricing based on job total

Price set to 1% of job total



# Item price based on percent

New subtotal breakdown panel

Includes total of items priced by percent of job

Trnsport CES

File Edit View Utilities Window Help

Job Number: CFAI16295-COPY Description 1: FAI-33-17.44  
Description 2:

Inflation Type: Job

| Item Estimate Totals       |               | Cost Group Estimate Totals |      |
|----------------------------|---------------|----------------------------|------|
| Bid-Based Tasks:           | 1,115,488.12  | Bid-Based Tasks:           |      |
| Inflation:                 | 0.00          | Inflation:                 |      |
| Non Bid-Based Tasks:       | 13,506,017.14 | Non Bid-Based Tasks:       |      |
| Inflation:                 | 0.00          | Inflation:                 |      |
| Item Sub-Total:            | 14,621,505.26 | Cost Group Sub-Total:      |      |
| Percent Tasks:             | 146,215.05    | Percent Tasks:             |      |
| Item Estimate:             | 14,767,720.31 | Cost Group Estimate:       |      |
| Job Estimate:              | 14,767,720.31 | Contingency:               | 0.00 |
| <b>Total Job Estimate:</b> |               | <b>14,767,720.31</b>       |      |

Ready



# Using formula for percent

The screenshot shows the Trns-port CES software interface. The main window displays a list of items with columns for Line, Item, and Description. A task ID REF 001 is highlighted with the comment 'Uses formula'. The 'Calculation Rule' panel is open, showing the 'Percent on Top' option selected and the 'Percent' field set to 1.00. The 'Formula and Expression Builder' panel is also open, showing the 'Expression' field with the formula:  $IF(JOBITEMSUBTOTAL < 1000000, 1.5, IF(JOBITEMSUBTOTAL < 5000000, 1.25, 1))$ . The 'Result' field shows the value 1. The 'Select To Add To Expression' panel is open, showing the 'Library' set to TEST and the 'Columns/Functions' list containing Arithmetic/Truncation.

Use formula:  
 $if(jobitemsubtotal < 1000000, 1.5, If(jobitemsubtotal < 5000000, 1.25, 1))$

Replace with one task

Comment: Uses formula

Calculation Rule

Normal  
 Percent on Top

Price:  
Percent: 1.00

Formula and Expression Builder

Description:

Expression:  $IF(JOBITEMSUBTOTAL < 1000000, 1.5, IF(JOBITEMSUBTOTAL < 5000000, 1.25, 1))$

Result: 1

Select To Add To Expression

Library: TEST

Columns/Functions: Arithmetic/Truncation

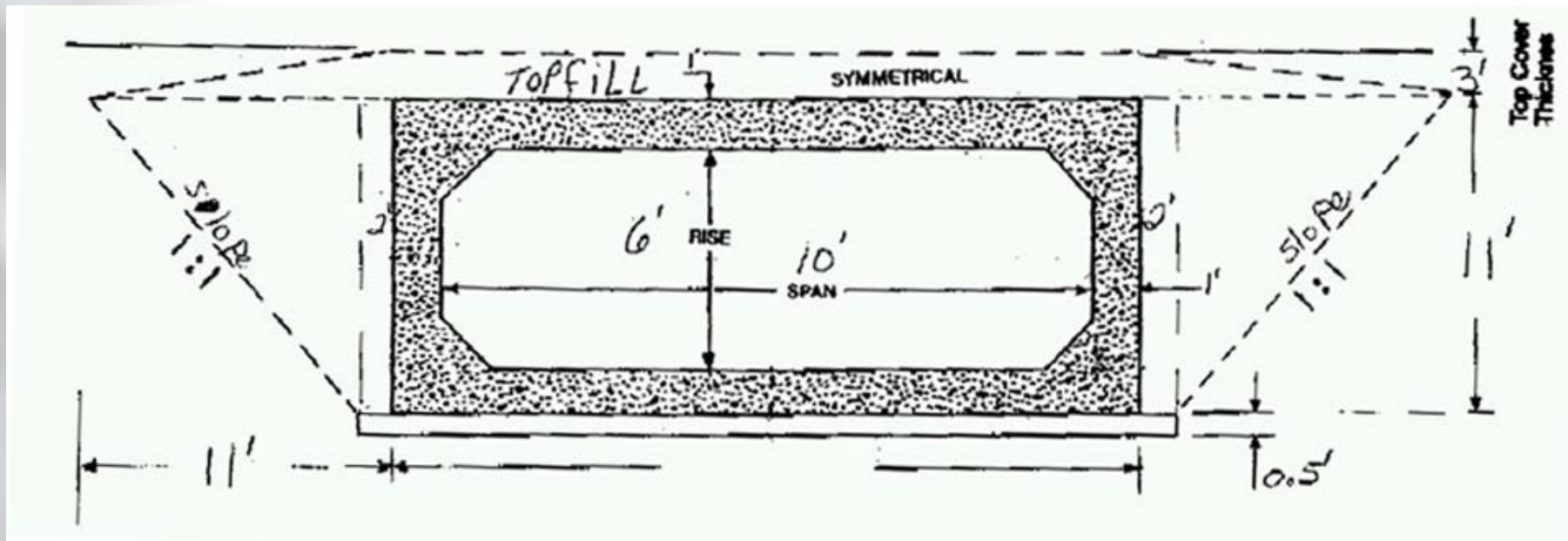
| Name | Express |
|------|---------|
|      |         |

# Using variables at the item level

- Look at commonly used items that have only a few attributes that vary between jobs
- Create variables for the Estimator to use for the values of the attributes
- Build a formula using the variables to perform the calculations

# Box Culvert

- Attribute that changes between jobs
  - Height of Cover is used the calculation for excavation and backfill





# Sample spreadsheet

| Height of Cover: 3'         |          |          |          |          |
|-----------------------------|----------|----------|----------|----------|
| <b>10' x 6' Box Culvert</b> |          |          |          |          |
|                             | Width    | Depth    | Cu. Yd./ | Cost /   |
|                             | Lin. Ft. | Lin. Ft. | Lin. Ft. | Lin. Ft. |
| <b>Excavation</b>           |          |          |          |          |
| Area of Culvert             | 16.00    | 11.00    | 6.52     |          |
| Left Side                   | 11.00    | 11.00    | 2.24     |          |
| Right Side                  | 11.00    | 11.00    | 2.24     |          |
| Total:                      |          |          | 11.30    | 165.00   |
|                             |          |          |          |          |
| Bedding                     | 16.00    | 0.50     | 0.30     |          |
| <b>Backfill</b>             |          |          |          |          |
| Backfill                    | 16.00    | 11.00    | 6.52     |          |
| Left Side                   | 11.00    | 11.00    | 2.24     |          |
| Right Side                  | 11.00    | 11.00    | 2.24     |          |
| Sub - Total                 |          |          | 11.30    |          |
| Minus Culvert               | 12.00    | 8.00     | 3.56     |          |
| Total:                      |          |          | 7.74     | 193.52   |
|                             |          |          |          |          |
|                             |          |          |          |          |
|                             |          |          |          |          |



# Spreadsheet formulas

|                      | Height of Cover: 3' |                |                      |            |
|----------------------|---------------------|----------------|----------------------|------------|
| 10' x 6' Box Culvert | Width               | Depth          | Cu. Yd./             | Cost /     |
|                      | Lin. Ft.            | Lin. Ft.       | Lin. Ft.             | Lin. Ft.   |
| <b>Excavation</b>    |                     |                |                      |            |
| Area of Culvert      | = $(10+1+1+2+2)$    | = $(6+1+1+C1)$ | = $(B6*C6)/27$       |            |
| Left Side            | =C7                 | =C6            | = $0.5*(C7*B7)/27$   |            |
| Right Side           | =C8                 | =C6            | = $0.5*(C8*B8)/27$   |            |
| Total:               |                     |                | = $SUM(D6:D8)+D11$   | = $D9*15$  |
| Bedding              | = $(10+1+1+2+2)$    | 0.5            | = $(C11*B11)/27$     |            |
| <b>Backfill</b>      |                     |                |                      |            |
| Backfill             | = $(10+1+1+2+2)$    | = $(6+1+1+C1)$ | = $(B14*C14)/27$     |            |
| Left Side            | =C15                | =C14           | = $0.5*(C15*B15)/27$ |            |
| Right Side           | =C16                | =C14           | = $0.5*(C16*B16)/27$ |            |
| Sub - Total          |                     |                | = $SUM(D14:D16)$     |            |
| Minus Culvert        | = $(10+1+1)$        | = $(6+1+1)$    | = $-C18*B18*27$      |            |
| Total:               |                     |                | = $SUM(D17+D18)$     | = $D19*25$ |



# Create Variables

Trns-port CES

File Edit View Utilities Window Help

Job TWO

General Variables Cost Groups Categories **Items** Programs Funding Attachments

Items for Job TWO

- Line: 0001 Item: 603E95201 Desc: 10X6' CONDUIT, A, 706.05, ...
  - Task ID: BID BASED Comment: REGRESSION MODEL 1
  - Task ID: TGRP 001 Group Name: CULVERT
    - Task ID: COST 001 Cost Sheet ID: CONDUITEXCAVATIO
    - Task ID: COST 002 Cost Sheet ID: CULVERTREMOVAL
    - Task ID: COST 003 Cost Sheet ID: CULVBACKFILL
  - Task ID: TGRP 002 Group Name: REMOVAL
    - Task ID: COST 004 Cost Sheet ID: CULVREMOVE

Item: 603E95201 Description: 10X6' CONDUIT, A, 706.05,APP  
Units: LF LS Units: Supp. Proposal Desc.:  
Quantity: 100.000 Unit Price: 369.25845 Extended Amount: 36,925.  
Line Number: 0001 Alternate Code:  
Item: 603E95201 Quantity: 100.0000  
Comment:  
Supp. Desc. 1:  
Supp. Desc. 2:  
Category: Req. Supp. Desc.?:   
Funding Code: Fixed Price?:   
Code 1: State Furnished?:

**Item Variables**

| Name           | Value        | Description   |
|----------------|--------------|---------------|
| COVERHEIGHT    | 3.0000000000 | in feet       |
| CONSTANTS      |              |               |
| AREAOF CULVERT | 6.5200000000 | for reference |
| SIDES          | 4.4800000000 | for reference |
| BEDDING        | 0.3000000000 | for reference |

Ready

CoverHeight variable plus constants, AreaOfCulvert, Sides, and Bedding



# Add formula to cost sheet

Trns-port CES

File Edit View Utilities Window Help

Job TWO

General Variables Cost Groups Categories **Items** Programs Funding Attachments

Items for Job TWO

- Line: 0001 Item: 603E95201 Desc: 10X6' CONDUIT, A, 706.05, /
- Task ID: BID BASED Comment: REGRESSION MODEL 1
- Task ID: TGRP 001 Group Name: CULVERT
- Task ID: COST 001 Cost Sheet ID: CONDUITEXCAVATIO
- Task ID: COST 002 Cost Sheet ID: CULVERTREMOVAL

Item: 603E95201 Description: 10X6' CONDUIT, A, 706.05,APP  
Units: LF LS Units: Supp. Proposal Desc.:  
Quantity: 100.000 Unit Price: Extended Amount:  
General  Labor  Material  Equipment

Task ID: COST 001  
Cost Sheet ID: CONDUITEXCAVATIO  
Description: EXCAVATION FOR CONDUIT  
Hours Per Day: 8.0000  
Overtime Per Day: 0.0000  
Unit: CY

|                        | Labor    | Equipment | Materials |
|------------------------|----------|-----------|-----------|
| Quantity or Unit Cost: | 1,132.84 | 672.80    | 0.00      |
| Overhead Pct. (%):     | 0.0000   | 0.0000    | 0.0000    |
| Component Total:       | 1,132.84 | 672.80    | 0.00      |

Production Rate: 120.0000  
Cost Sheet Unit Subtotal: 15.05  
Management Percentage (%): 0.0000  
Cost Sheet Unit Price: 15.04533  
Quantity Per Item Unit: CULVERT+SIDES+BEDDING,2  
Unit Price:

Ready

Enter formula for  
Cubic Yards per Linear Feet:  
AreaOfCulvert+Sides+Bedding





# Create Variables

Trns-port CES

File Edit View Utilities Window Help

Job TWO

General Variables Cost Groups Categories **Items** Programs Funding Attachments

Items for Job TWO

- Line: 0001 Item: 603E95201 Desc: 10X6' CONDUIT, A, 706.05, /
  - Task ID: BID BASED Comment: REGRESSION MODEL 1
  - Task ID: TGRP 001 Group Name: CULVERT
    - Task ID: COST 001 Cost Sheet ID: CONDUITEXCAVATIO
    - Task ID: COST 002 Cost Sheet ID: CULVERTREMOVAL
    - Task ID: COST 003 Cost Sheet ID: CULVBACKFILL
  - Task ID: TGRP 002 Group Name: REMOVAL
    - Task ID: COST 004 Cost Sheet ID: CULVREMOVE

Item: 603E95201 Description: 10X6' CONDUIT, A, 706.05,APP  
Units: LF LS Units: Supp. Proposal Desc.:  
Quantity: 100.000 Unit Price: 369.25845 Extended Amount: 36,925.

General  Labor  Material  Equipment

Task ID: COST 001  
Cost Sheet ID: CONDUITEXCAVATIO  
Description: EXCAVATION FOR CONDUIT  
Hours Per Day: 8.0000  
Overtime Per Day: 0.0000  
Unit: CY

|                     | Labor    | Equipment | Materials |
|---------------------|----------|-----------|-----------|
| Daily or Unit Cost: | 1,132.84 | 672.80    | 0.00      |
| Overhead Pct. (%):  | 0.0000   | 0.0000    | 0.0000    |
| Component Total:    | 1,132.84 | 672.80    | 0.00      |

Production Rate: 120.0000  
Cost Sheet Unit Subtotal: 15.05  
Markup Percentage (%): 0.0000  
Cost Sheet Unit Price: 15.04533  
Quantity Per Item Unit: 11.300  
Unit Price: 170.01227

Ready

Result:  
11.30



# Change cover height

Trns-port CES

File Edit View Utilities Window Help

Job TWO

Item: 603E95201 Description: 10X6' CONDUIT, A, 706.05,APP  
Units: LF LS Units: Supp. Proposal Desc.:  
Quantity: 100.000 Unit Price: 369.25845 Extended Amount: 36,925.

Line Number: 0001 Alternate Code:  
Item: 603E95201 Quantity: 100.0000  
Comment:  
Supp. Desc. 1:  
Supp. Desc. 2:  
Category:  
Funding Code:  
Code 1: State Furnished:

Task ID: COST 001  
Task ID: COST 002  
Task ID: COST 003  
Task ID: TGRP 002 Group Name  
Task ID: COST 004 Cost Sheet

CAVATIO  
REMOVAL  
WLL  
E

| Name           | Value        | Description   |
|----------------|--------------|---------------|
| COVERHEIGHT    | 3.0000000000 | in feet       |
| CONSTANTS      |              |               |
| AREAOF CULVERT | 6.5200000000 | for reference |
| SIDES          | 4.4800000000 | for reference |
| BEDDING        | 0.3000000000 | for reference |

Ready

Height at 3 ft

Price = \$369

Area = 6.52



# Change cover height

Change Cover Height to 6 ft

The screenshot shows the Trns-port CES software interface. The main window displays job details for 'Job TWO'. The 'Item' field is set to '603E95201' with a description of '10X6' CONDUIT, A, 706.05,APP'. The 'Quantity' is 100.0000 and the 'Unit Price' is 560.96079. The 'Line Number' is 0001. The 'Item Variables' table is visible at the bottom of the window.

| Name           | Value        | Description   |
|----------------|--------------|---------------|
| COVERHEIGHT    | 6.0000000000 | in feet       |
| CONSTANTS      |              |               |
| AREAOF CULVERT | 8.3000000000 | for reference |
| SIDES          | 7.2600000000 | for reference |
| BEDDING        | 0.3000000000 | for reference |

Result: Price = \$560

Result: Area = 8.3



# Benefits of CES Formulas

- Assist with building the estimate
  - Allows take-offs previously done externally to be integrated within CES
  - Supports multiple levels of tasks
    - From basic number calculations to the creation of variables to store specific calculations
  - Preserves the methods the estimate was built from for later review and updates
- Save time and provide consistency across estimates

# Using Formulas in CES<sup>®</sup>

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QUESTIONS

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