# ~ Good Gravel ~

## Gravel Crushing Contract Workshop

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# 3 Critical Elements for Good Gravel

- Adequate Gravel Source (may require additives)
- Good Specification
- Good Quality Assurance

# Presentation Outline

- **Objective**: Crush better gravel to reduce blading, dust, gravel loss and costs.
- Scope of Problem:
  - 2013 South Dakota Study
  - 2013 North Dakota Survey
- Improvement Areas
- Successful Examples
  - Wetaskiwin County, Alberta
  - Sheridan County, Wyoming
  - Johnson County, Wyoming
  - Others?

**Improvement Areas**
Type of Contract
Gravel Pit Investigation
Gravel Specs
Sampling
Testing
Quantity Measurement
Acceptance Options
Contract Admin

# 2013 South Dakota Gravel Study

- 9 project gravels sampled
- 6 failed on top size
- 4 failed on plasticity index
- Gravel performance not measured
- Problems Areas
  - County quality assurance/contract administration
  - Clay soil/additive needed if pits are non-plastic

# 2013 Survey on Rock Crushing

## 20 of 53 North Dakota Counties Responded

| Unit of Measure | % (a) | Annual Quantity | | $/Unit | Ann $ |
|---|---|---|---|---|---|
| | | Range | Ann Total | | |
| Tons | 21 | 10,000 to 175,000 | 445,000 | $3.51 | $1,600,000 |
| Cubic Yards | 70 | 2,000 to 175,000 | 705,000 | $5.05 | $3,500,000 |

(a) 7% screened, 2% Pit Run

# Workshop Handouts (Electronic)

- Power Point Presentation
- Guide Specifications to Consider
- FS Gravel Pit Development Plan Guide
- Excel Tools
  - Stockpile & Crusher Footprint Estimator
  - Gravel Quantity Estimator
  - Pit gradation blending calculator
  - Gravel Spread Chart
  - Water Quantity Estimator
  - FHWA Pay Factor Program and Manual
- Contract Administration Checklist
- One Page Summary of Contract Changes, Sheridan & Johnson County WY

# Gravel Problems & Solutions

| Problem Area | Problem | Problem Consequences | | | Typical Solutions |
|---|---|---|---|---|---|
| | | Initial | | Final | |
| **Gravel Source Investigation** | Gravel depths not known | High bids | Claims | High Life Cycle Costs | More test pits to define overburden, etc. |
| | Poor Quality, no clay, etc. | Short Gravel Life | | | Consider borrow source & additives |
| | Inadequate Quantity | High Admin Costs | Owner pays for Crusher move | | More test pits<br>More sampling & testing |
| ★ **Gravel Performance** | Dust | Bad Public Relations | Gravel Loss, Short Life | High Life Cycle Costs | Better gradation & PI specs Dust abatement Additives, etc. |
| | Washboards, raveling, ruts | | | | Better gradation<br>Higher % Fracture |

# Gravel Problems & Solutions

| Problem Area | Problem | Problem Consequences | | | Typical Solutions |
|---|---|---|---|---|---|
| | | Initial | | Final | |
| Sampling & Testing | Bias sampling from belt | Out of Spec gravel | Gravel loss | High Life Cycle Costs | Surge pile or stockpile samples<br>Surveillance cameras |
| | Inaccurate Testing | | | | Qualified Consultants Check sample testing |
| | Inadequate Contract Administration | Short Gravel Life | | | More training<br>More County people<br>Surveillance cameras |
| | Contractor not interested in Quality | | | | Pay incentive/reduction spec |

# Gravel Problems & Solutions

| Problem Area | Problem | Problem Consequences | | | Typical Solutions |
|---|---|---|---|---|---|
| | | Initial | | Final | |
| Quantity ★ | Belt Scale calibration or manipulation | High Contract Admin Costs | Higher cost gravel | High Life Cycle Costs | Payment Quantity:<br>By CY in stockpile<br>Actual Measured Quantity |
| | Quantity Disputes | | | | |
| | Contractors don't like CY payment | High bids | | | Get Contractor review of spec<br>Require mandatory prebid meeting |
| Contract Issues | New Specs not understood by Bidders | High Bids | | High Life Cycle Costs | Get Contractor review of spec<br>Require mandatory prebid meeting |
| | Contractor files claim | High Admin Costs | | | Prework meeting,<br>Require timely claim filing |
| | Poorly qualified low bidder | High Admin Costs | Low Quality Gravel | | Award to bidder closest to average of lowest three bids<br>Ask for proposals & negotiate price |

# Type of Contract Award

**Improvement Areas**
**Type of Contract**
Gravel Pit Investigation
Gravel Specs
Sampling
Testing
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Contract Admin

- Low bidder (Ref: normal state contracting statutes)
- Closest to Average of Lowest ‘x’ bids (Ref: Florida DOT)
- Manditory Pre-Bid Meeting Attendance
- Bidder Prequalification (*www.dir.ca.gov/od_pub/prequal/pubwksprequalmodel.rtf*)
- Proposal & Negotiated Price (Ref: FAR Subpart 15.203)
- Consult with your County Attorney

# Proposal Rating Elements & Weight

| Rating Elements | Weight |
|---|---|
| Experience: Years of experience in crushing in similar gravel pits for Foreman and shift supervisor that will be used on the project | 20 |
| Performance: List last 5 crushing contracts with owner contact information, contract tonnage or cubic yards, days crushing | 15 |
| Disputes and Litigation: List any disputes that led to changing prices or quantities on a contract during the past 5 years | 20 |
| Method for taking acceptance samples | 10 |
| Equipment and method proposed for stockpiling | 10 |
| What “value added benefits” will you be providing if any | 10 |
| Truthful and complete information provided in Proposal | 10 |
| Attendance at pre-proposal meeting | 5 |

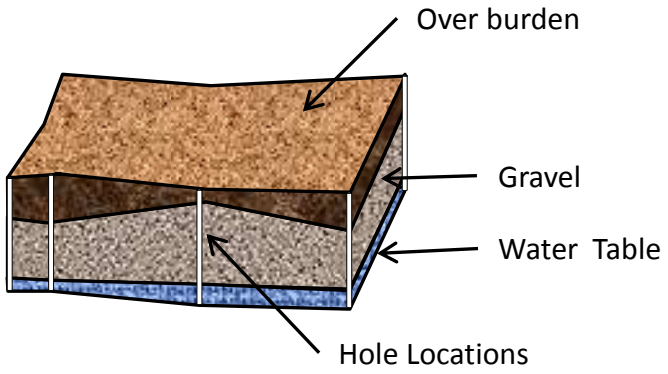
# Bidding Factors

- Gravel Pit:
  - Familiar with pit or general area or not,
  - Easy or difficult,
  - Quality of investigation
- Specs:
  - Easy versus difficult,
  - Match pit or not,
  - Type of spec (pay incentive, etc)
- Large or small quantities
- Large versus small crushing spread
- Contractor is booked up with work, or not
- Required completion time and season
- Past relationship with owner
- Local Contractor maintaining relationships
- Non-local contractor attempting to develop relationships

Discuss proposed changes with local contractors to ensure you understand Bidding Factors

# Gravel Pit Investigation

- Purpose of Investigation
  - Reduce Costs
  - Determine pit run gradations
  - Pick Realistic Spec Requirements
  - Determine need for additives or select borrow
  - Determine overburden depth, depth to water table, depth of deposit, gravel quantities available
- Investigation Process
  - Separate excavated material by depth
  - At least three sample areas per pit
  - Test samples
  - Calculate quantity available
  - Prepare pit development plan
- References
  - ASTM D420-98 (2003) Conducting Geotechnical Subsurface Investigations
  - FS Pit Development Guide, Plan and Checklist with standard disclaimers




**Improvement Areas**
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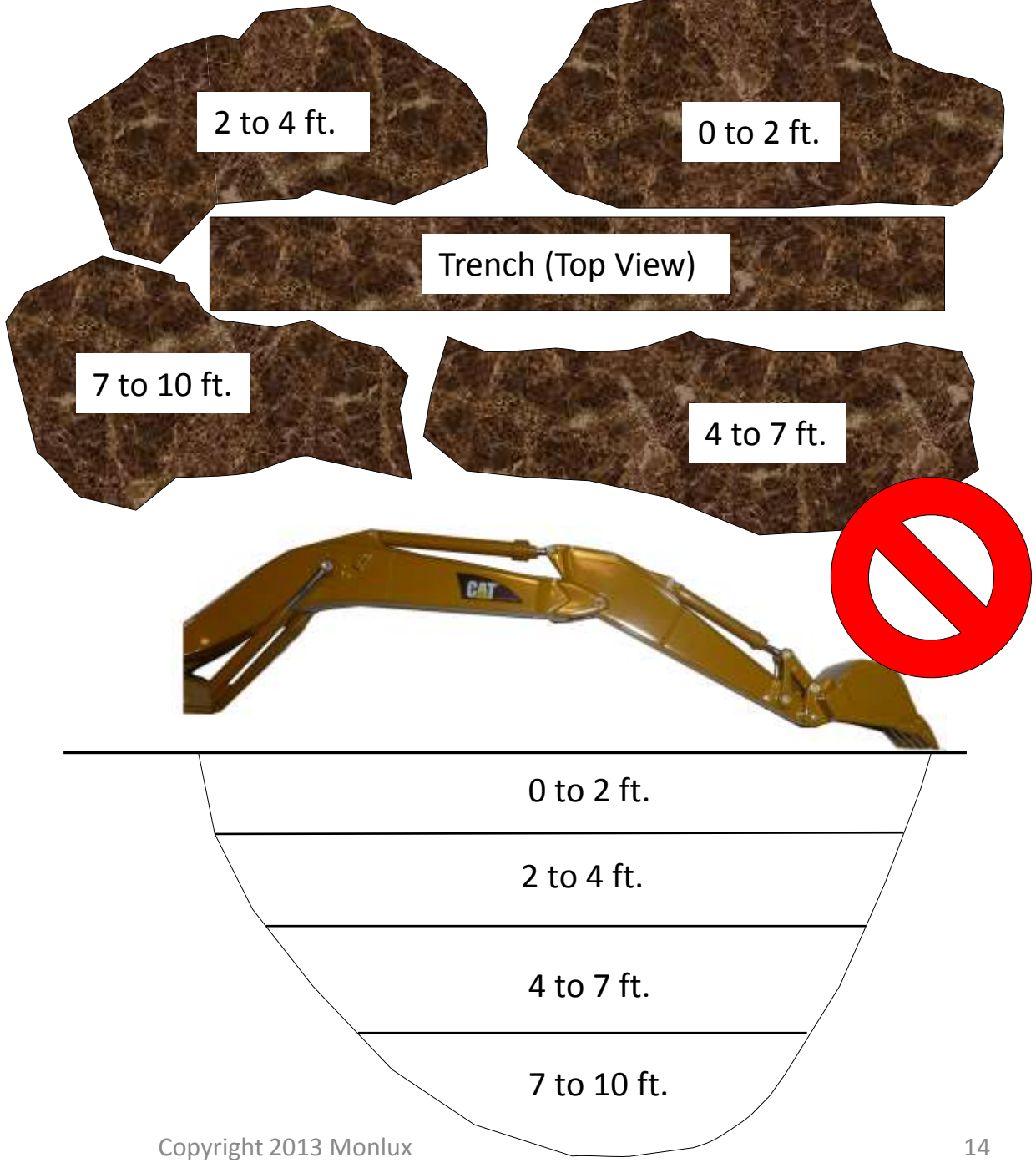
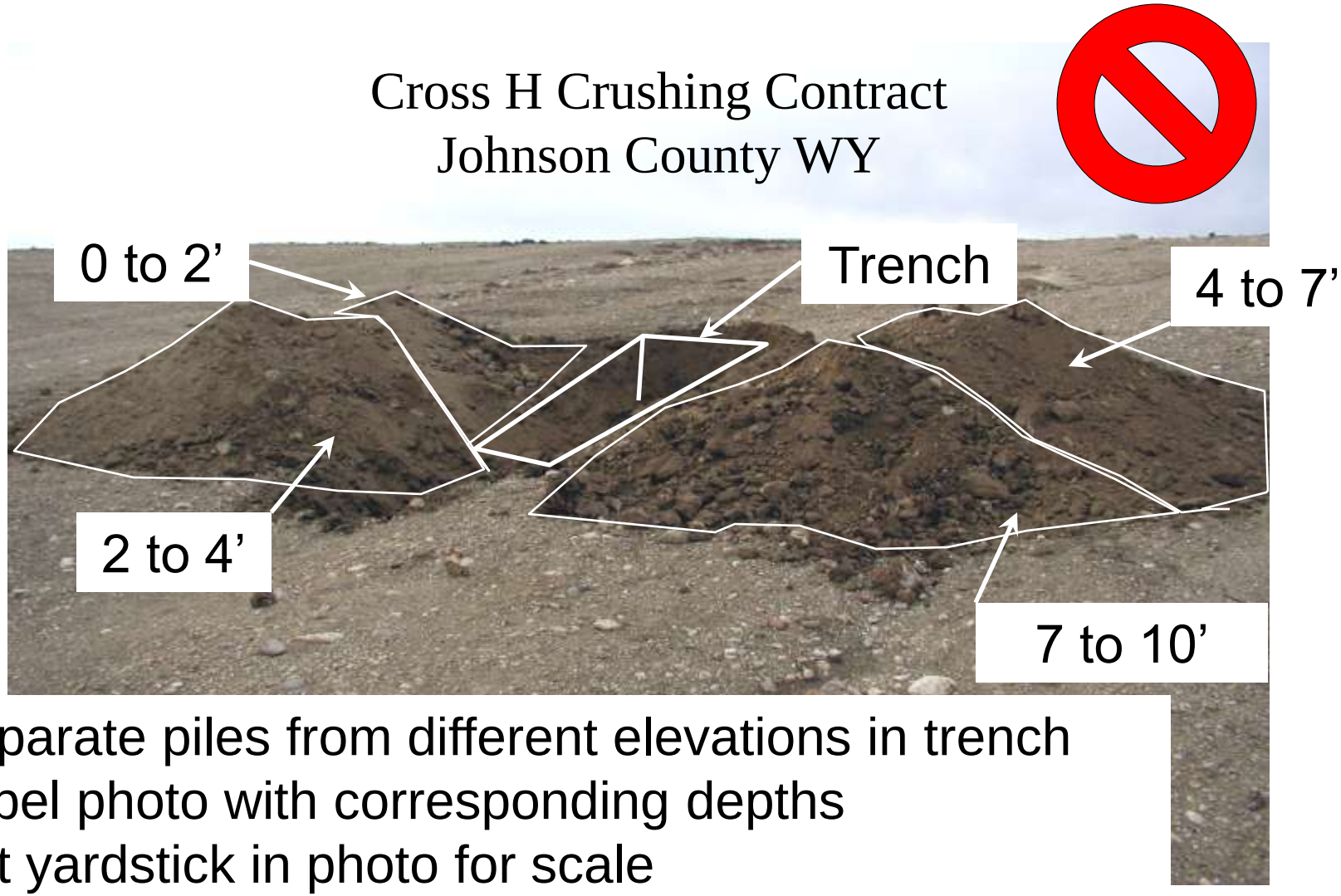
# Sampling with Backhoe or Excavator

Sample from piles beside trench, not from trench walls

Ref: AASHTO T2, ASTM D 75 Appendix X2.3.2



# Sampling with Excavator




Separate piles from different elevations in trench
Label photo with corresponding depths
Put yardstick in photo for scale

# Gravel Pit Plan Checklist (FS Guide)

- Drawings
  - Topographic features (contours, roads, stockpiles, outcrops, etc.)
  - Location of test holes
  - Plan & Cross section views of excavation limits to obtain quantities
  - Areas for crusher and stockpiles (crushed rock, overburden, etc.)
- Test Hole Information
  - Graphics that shows depth of material layers
  - Layer thicknesses of topsoil, overburden, gravel
  - Estimates of % Boulders, Cobbles, Gravel, Sands % Fines
  - Test results from layers
  - Water table if encountered
  - Depth of proposed pit floor, and if encountered, bedrock & water table
- Photos of excavated materials with yard stick for scale
- References: ASTM D 420, D75 & Idaho T 142

**Guide ¶ 8.1**

# Gravel Pit Plan Notes (FS Guide)

- Disclaimer for Test Results on Gravel Pit:
  - "The quality of material in the provided pit is acceptable in general, but may contain layers or pockets of unacceptable materials. It is not feasible to ascertain from samples the quality of material for an entire deposit, and variations may be expected."
- Suitability of the Gravel Pit.
  - "The Contractor may have to selectively utilize materials from different areas of the source, blend, sort, reject, re-screen or import materials (clay, sand, etc), as well as use special crushing, screening, excavation and other types of equipment to meet specifications. No additional compensation will be given for these efforts."



**Guide ¶ 8.1**

## Materials Source Development Plan Checklist

**Vicinity Map**
1. Map area that includes major landmark (Google Earth?)
2. Arrow that shows location of Pit
3. Existing roads and distance to nearest town
4. North Arrow and map scale

**Plan View of Rock Source**
1. Scale: _ inch = _ feet & graphic of 0' to 50' to 100' to 150'
2. Site for Crusher (1/4 Ac min) and areas for stockpiling aggregate, topsoil, overburden, waste, reject, etc
3. North arrow
4. Road mile distance to local landmark
5. Locations of cross section lines "A-A", "B-B", etc
6. Contour Lines
7. Access Roads and other existing features
8. Drainage direction on pit floor
9. GPS Coordinate locations of test holes, seismic lines, pit development boundaries, clearing limits, excavation limits, visual screens to be undisturbed, existing roads and roads to be constructed.
10. Location of unacceptable materials
11. Panoramic or satellite photo of source

**Cross Sectional Views**
1. Scale: _ inch = _ feet
2. Profile of existing ground, side slopes for excavation limits, location of clear limits, slope rounding, etc
3. Elevation scale on vertical axis
4. Pit Floor elevation and drainage direction
5. Location of unacceptable materials
6. Elevation of ground water and bedrock if known

**Data to Include from Source Investigation**
1. Date and type of exploration, name of field personnel
2. Physical location of drill holes or test pitsholes by GIS coordinates or other means
3. Physical properties of material by depth below the ground surface. Use ASTM D 2487 (USCS), D 2488 (field USCS)and D 5878 (URCS) as appropriate. Essential items are depth of overburden, plasticity and percent Boulders, Cobbles, Gravel, Sand & Fines.
4. Graphics that show depth of different material layers
5. Depth of hole and if ground water or bedrock was encountered.
6. Photos of cores or materials excavated from pits

## Notes To Be Placed On The Drawings

**Notes and Pit Plan Requirements**

1. The quality of material in provided sources is acceptable in general, but may contain layers or pockets of unacceptable materials. It is not feasible to ascertain from samples the quality of material for an entire deposit, and variations may be expected. Materials source investigation data is available upon request, including sample site locations, depth of sample[illegible]sults. The Contractor must determine the quantity and type of eq[illegible] necessary to select and produce acceptable materials.
2. Strip and stockpile topsoil and overburden. After op[illegible] comple shape the mined area to blend into the surrounding natu[illegible]rra[illegible]d as specified.
3. Control all erosion so the sediment levels in the bodie[illegible]ater wi drainage area of the work area do not increase. Control e[illegible]o that sediment does not leave the work area.
4. Use only approved portions of the right-of-way for storing mate[illegible]and location of plants and equipment. Restore the sites used to their original condition, or as shown on the plans.
5. If excess material is produced, it will be become the property of the agency.
6. Excavate or remove material only from within the grading limits, as indicated by the slope and grade lines. Keep all operations within pit development boundaries.
7. Haul roads and source development areas will be dust abated and maintained to control erosion as necessary during the duration of the contract.
8. All work will comply with MSHA 30 CFR, Part 56 (http://www.msha.gov/30cfr/56.0.htm)
9. Submit a written plan of operation that covers the following:
   a. Crusher component locations and support equipment storage areas
   b. Mine area excavation and utilization process
   c. Locations of all surge piles and stockpiles
   d. Plans and schedule for erosion control, dust abatement and restoration.
10. All work required in crushing, stockpiling, hauling, rock source development, dust abatement, erosion control and mobilization is incidental to payments for the quantity of aggregate specified. No separate payment will be made for these items.
11. If for any reason the Contractor cannot produce materials from the gevernment source, he may use a commercial source or import material from a commercial source at his expense.

**References:** ASTM D420, (AASHTO R13) D75 & Idaho

**Materials Source Development Plan Guide**

(Project or Rock Source Name, Sheet _ of _)

(Agency Name & Date Plan Approved)

# Gravel Pit Problems & Solutions

- Not enough minus #200 or too little sands
  - High speed cone crushers, Vertical shaft impact crushers, Reject some of the crushed rock, Import borrow source with sands or minus #200, Keep cone crushers “choke fed”
- Too much sand in source
  - Selective feed from pit, Reject a portion of minus #4, use high frequency reject screens, Increase percentage of crushed rock to offset sands content
- Low Plasticity Index: Add bentonite or clay borrow source fines
- Source with clay and high moisture content
  - Selectively mine strata and land farm to dry out. Add back with feeder
  - Aerate by excavating and stockpiling pit run prior to crushing
- Use Excel Tool: “Pit Gradation Blending and Rejecting Tool” for gradation, test PI of blend. Google “Aggflow”

# ‘Good’ Gravel Spec

(Dry Climate Non-Quarry Rock)

**Improvement Areas**
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- **Gradation**

| Sieve | % Passing & PI |
|---|---|
| 1” | 100 |
| 3/4 | 97-100 |
| 3/8” | 67-83 |
| #4 | 48-68 |
| #16 | 25-42 |
| #40 | 17-30 |
| #200* | 12 to 18 if PI < 4 |
| | 8 to 12 if PI 4 to 12 |
| | 8 to 12 & PI < 4, add 2% Bentonite by aggregate weight and pug mill mix. |
| * Best suited for dry climates | |

- **% Fracture: > 75%**
- **Quality**
  - **Hardness: LAA < 40**
  - **Durability: $NaSO_4$ < 12%**
- **Are Gradation Specs realistic for pit?**
- **What works good in your area?**

GRM 42

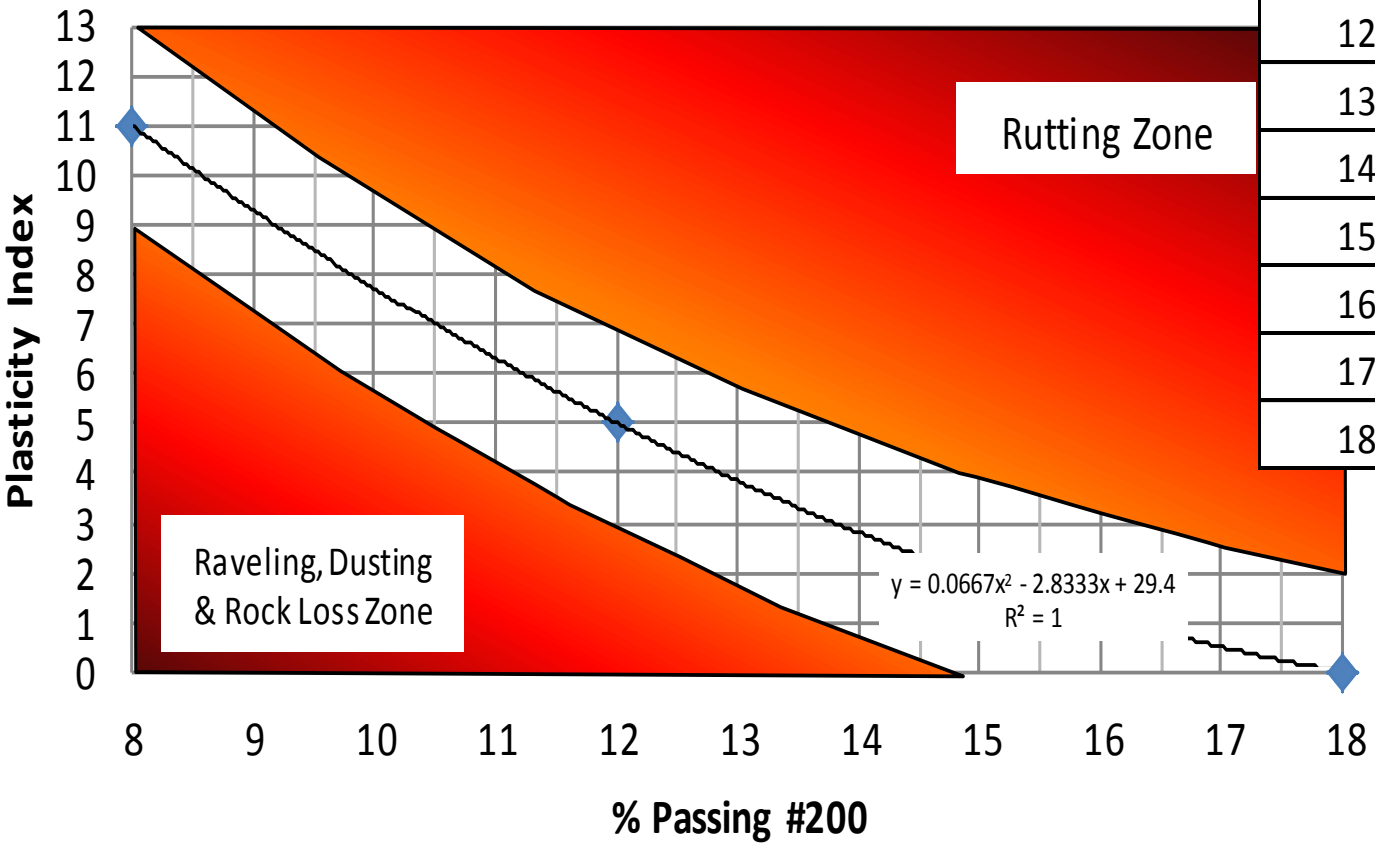
# Gravel Spec Selection

- Take gravel samples off roads that perform well and poorly.

- Test Gradation, % Fracture by size, and PI.
- Compare results.
- Build spec around good performing gravels so that poor performers will fail.

# PI and #200 Spec

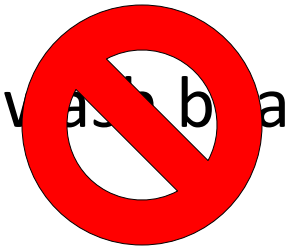
## PI and % Passing #200 (Dry Climates)



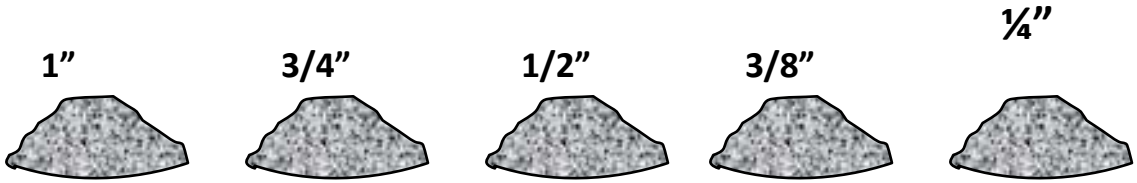

| #200-PI Table | | | |
|---|---|---|---|
| %#200 | PI Target | PI Range | |
| 8 | 11.0 | 9 | 13 |
| 9 | 9.3 | 7 | 11 |
| 10 | 7.7 | 6 | 10 |
| 11 | 6.3 | 4 | 8 |
| 12 | 5.0 | 3 | 7 |
| 13 | 3.8 | 2 | 6 |
| 14 | 2.8 | 1 | 5 |
| 15 | 1.9 | 0 | 4 |
| 16 | 1.1 | 0 | 3 |
| 17 | 0.5 | 0 | 3 |
| 18 | 0.0 | 0 | 2 |

# ‘Good’ Gravel Road Surfacing

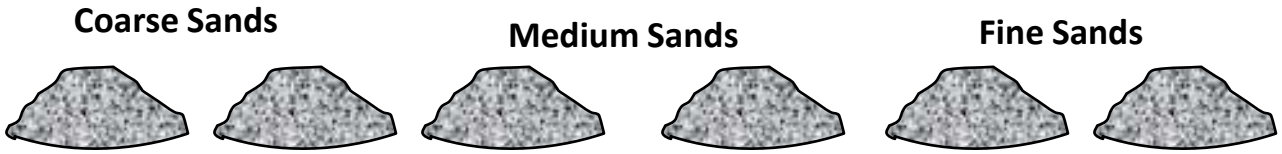
- Contain the right amounts of each size
- Have rock fracture for interlock less raveling, w[illegible] b[illegible]arding
- Contain enough clay



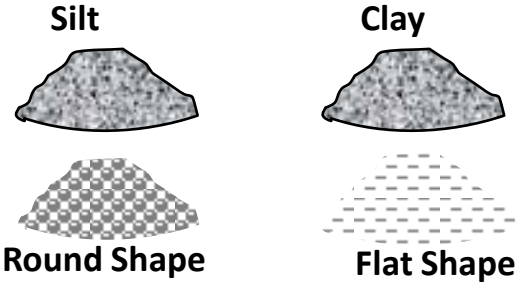
Gravel 1” x ¼”

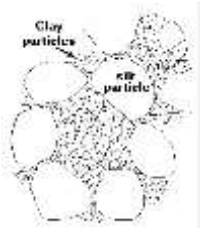



Sands




Fines (Binder or minus #200, Dust)




| Silt/Clay Size | |
|---|---|
| Avg ϕ | Volume |
| 30/1 | 15,000/1 |



GRM 41

# Sampling

- Three tasks to get gradation
  - Sampling, Splitting, Testing
- Sampling Responsibility → Contractor
- Sampling process details in specs
- Industry Standard Sampling Requirements

**Improvement Areas**
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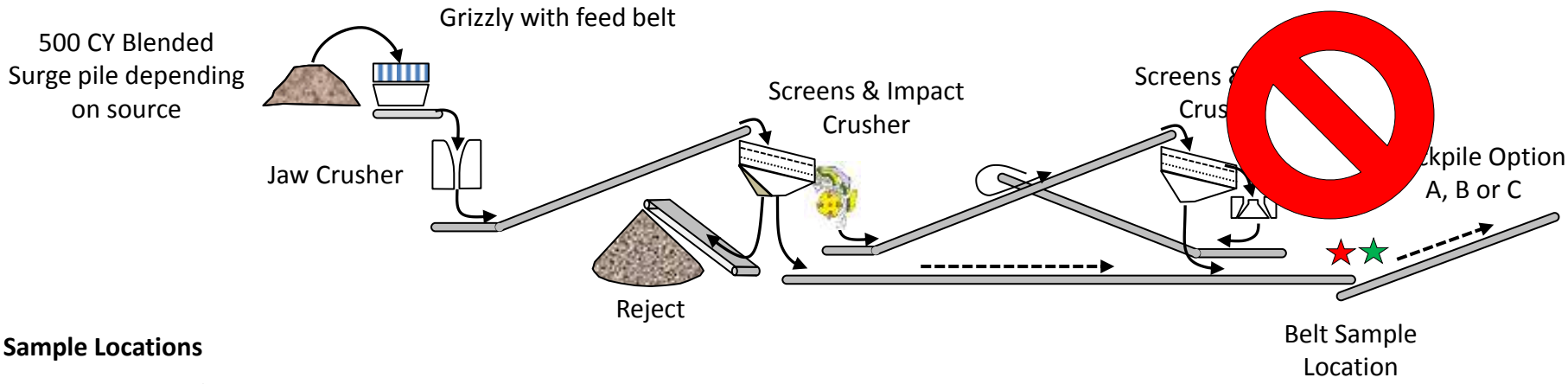
| Sample Type | Purpose of Sample | # Samples per Project | Primary Responsibility | |
|---|---|---|---|---|
| | | | Sampling | Testing |
| Crusher Control | Crusher adjustments | 3 to 5 per day | Contractor | Contractor |
| Acceptance Samples | Payment | 20 to 30 per Project | Contractor | Owners Consultant |
| Validation Samples (1) | Verify accuracy of acceptance Samples | 20 to 30 per project | Contractor | Owners Consultant |

(1) Not as critical if Owner has experienced personnel at the crusher site 24/7

# Sampling Locations & Stockpiling Options



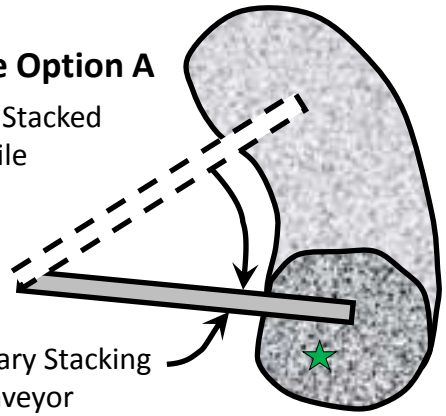

**Sample Locations**

Crusher Control ★

Acceptance or Validation ★

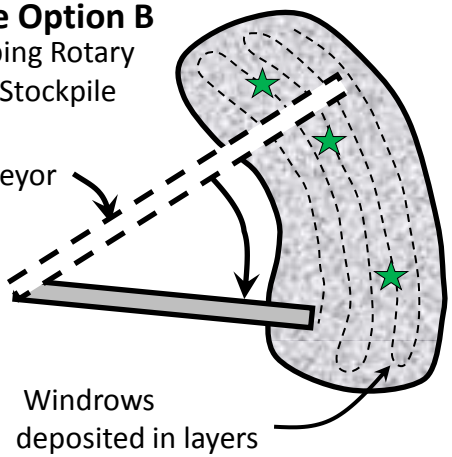
**Stockpile Option A**

Rotary Stacked Stockpile



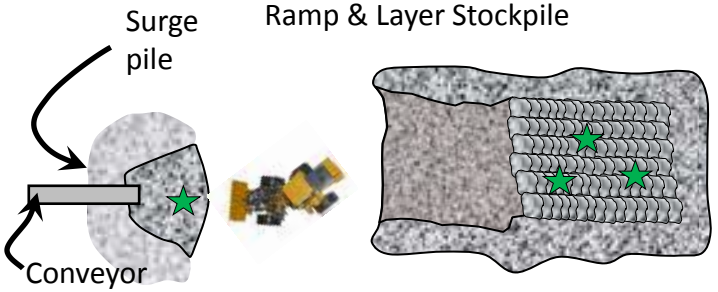

**Stockpile Option B**

Telescoping Rotary Stacked Stockpile




**Stockpile Option C**

Ramp & Layer Stockpile



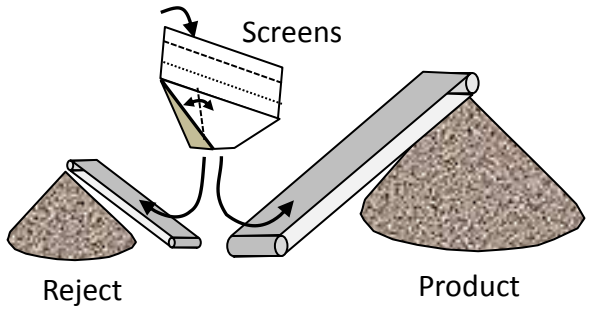
# Bias Sampling

- Unintended Bias:
  - Taking samples only when gravel “looks good”
  - Taking all daily samples at one time
- Intended Bias:
  - Selectively feeding crusher the best materials prior to taking samples
  - Making crusher adjustments just prior to taking samples
- Problems:
  - Owner can’t keep inspector on site 24/7
  - Belt Samples are a “snapshot” of production
  - Bias is a common problem in sampling
  - Gravel does not conform to specs
- Solutions:  See next slides

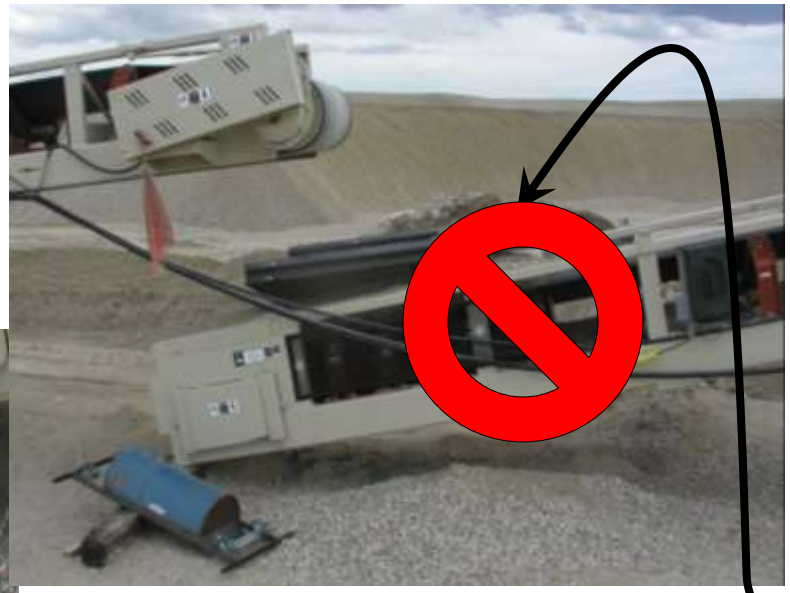
# Crusher Adjustments that Change Gradation

Why is this important?

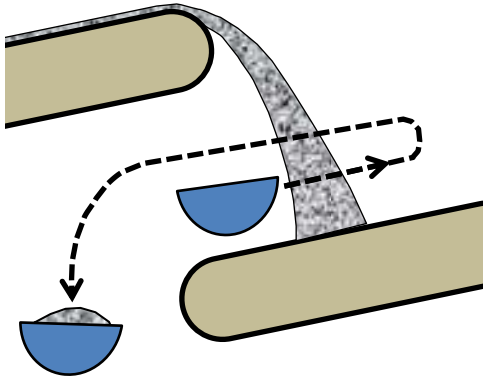
- "Select" pit run fed into crusher
  - Blend of specific materials within pit
  - Dry materials that screen more efficiently
- Feed rate change (Tons per Hour)
  - Increasing rates to "choke feed cones" increases #200
  - Reducing rates improves screening efficiency
- Reject gate adjustment



# “Snapshot” Crusher Belt Sampling



Rollers that ride on angle iron “rails”.



AASHTO T2
Pass sampler back and forth under gravel flow.
Make sure sampler doesn’t overflow
Do this three times, waiting between each time
Combine all materials and split to size for testing

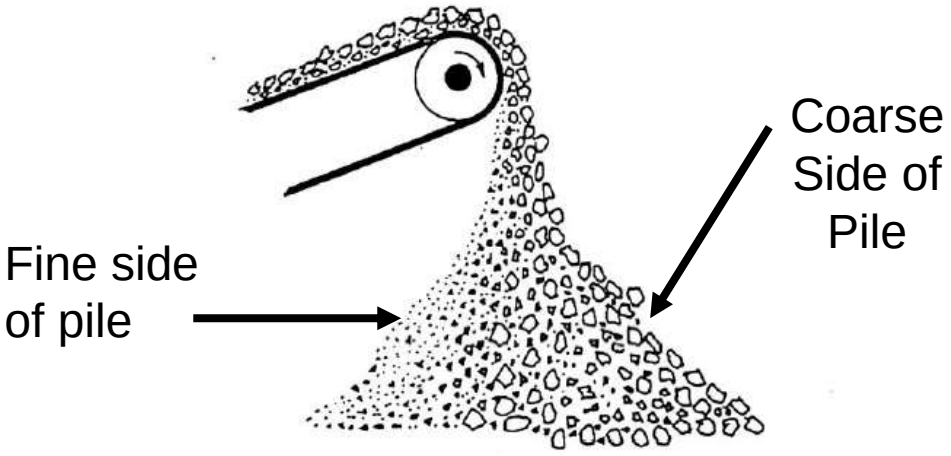
# Ways to Ensure Good Sampling & Good Gravel

- Spell out sampling requirements in specs
- 500 CY blended crusher feed surge pile
- **Large composite daily acceptance samples**
- **Sample with the Contractor**
- Consider prohibiting rotary stacking conveyors or restricting to 10 foot drop height
- Validation sampling & testing of finished work (stockpile)
- Surveillance cameras

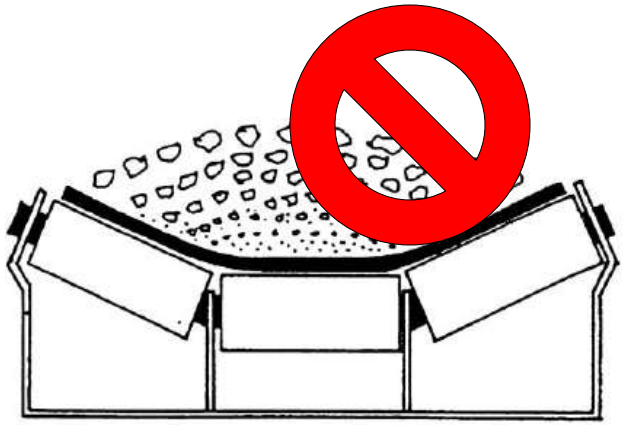
# Rotary Stacking Conveyers


**Stockpiling with Rotary Stacking Conveyor:**
**(1) Creates segregation**
**(2) Violates good stockpiling specs**
**(3) Reduces tonnage in pile**

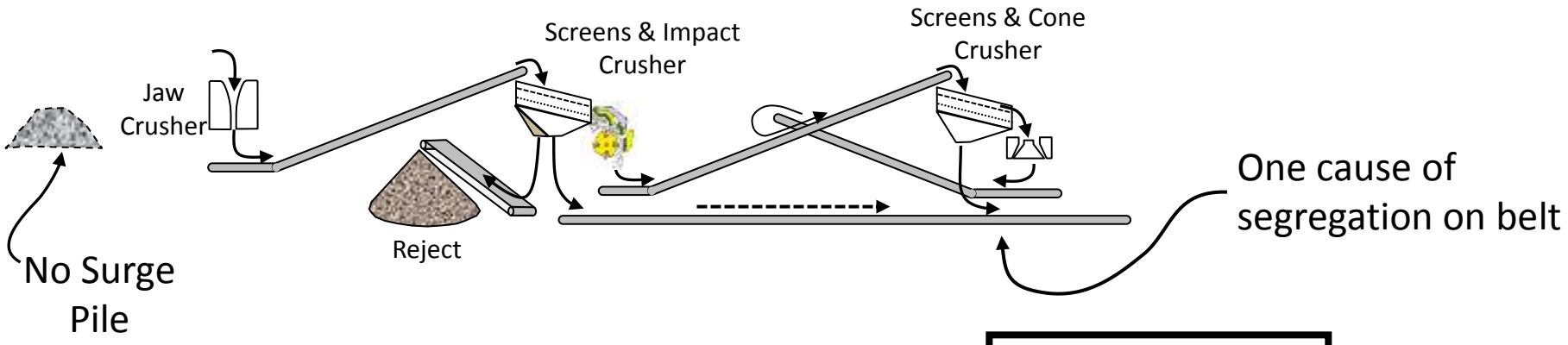
# Gravel Segregation During Crushing




Reduce 'roll down' segregation by lowering conveyor height, increasing moisture content



Coarse rock separates as conveyor belt goes over rollers






**Guide ¶ 4.9.2**

# Spec Options that Reduce Segregation

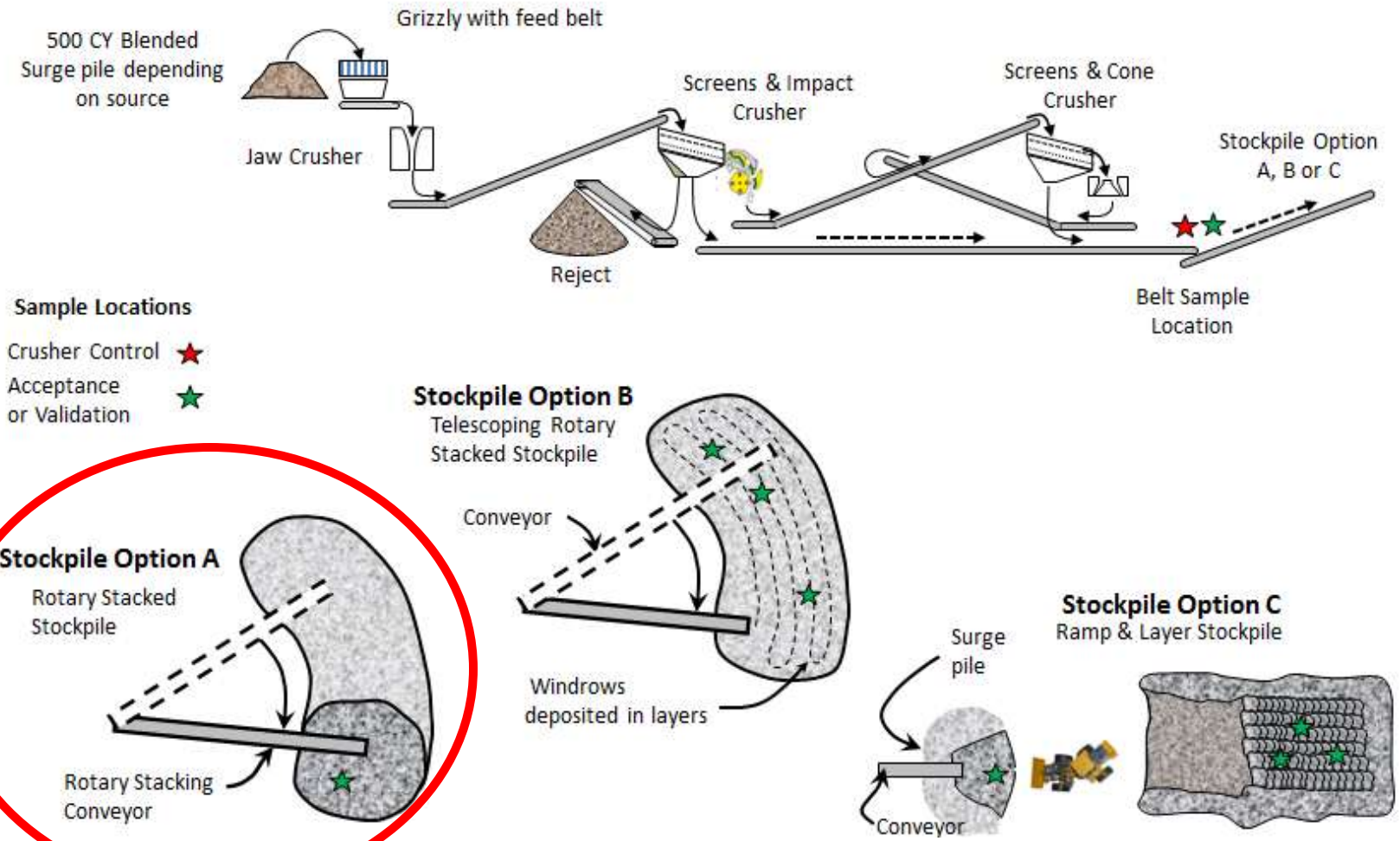
- Require crusher feed from surge pile
- Require specific equipment
  - Pug mill mixing with water
  - Telescoping rotary stacking conveyors
- Prohibit specific equipment
  - Traditional rotary stacking conveyors
- Require specific stockpiling procedure
  - Build stockpiles in layers less than 8 feet deep

# Daily Composite Samples

**General Method**

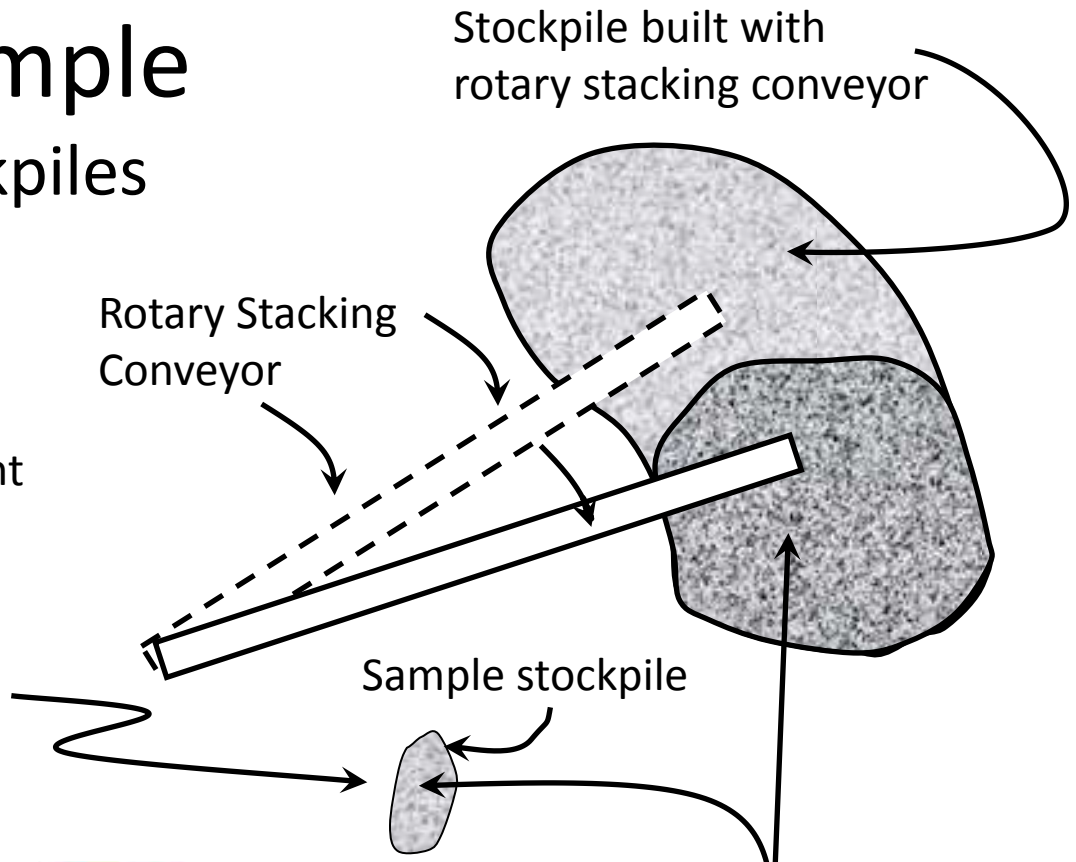
- 3 or more front end loader buckets throughout day
- Loader piles mixed and then flattened to 1 to 2 foot thickness
- 5 or more sample locations from interior of flattened pile

# Sampling Locations & Stockpiling Options

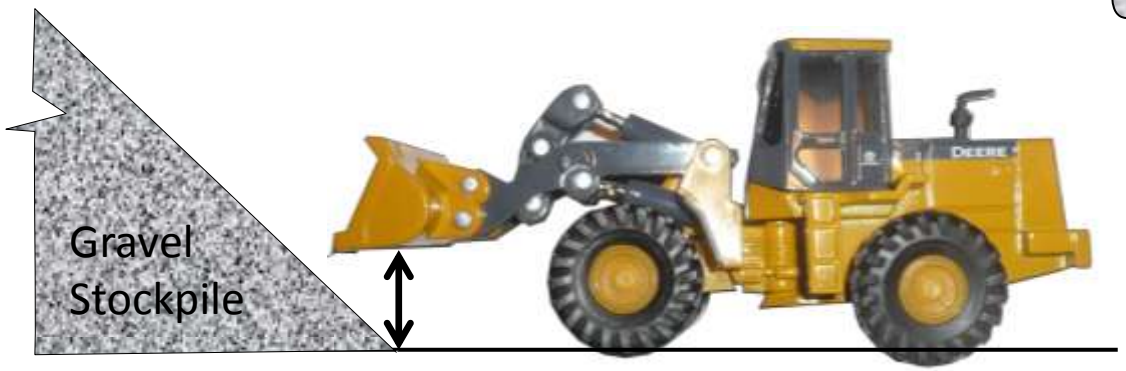


# Acceptance Sample

## Rotary Stacker Stockpiles




Samples are taken with the front end loader bucket at multiple times to form a composite acceptance sample

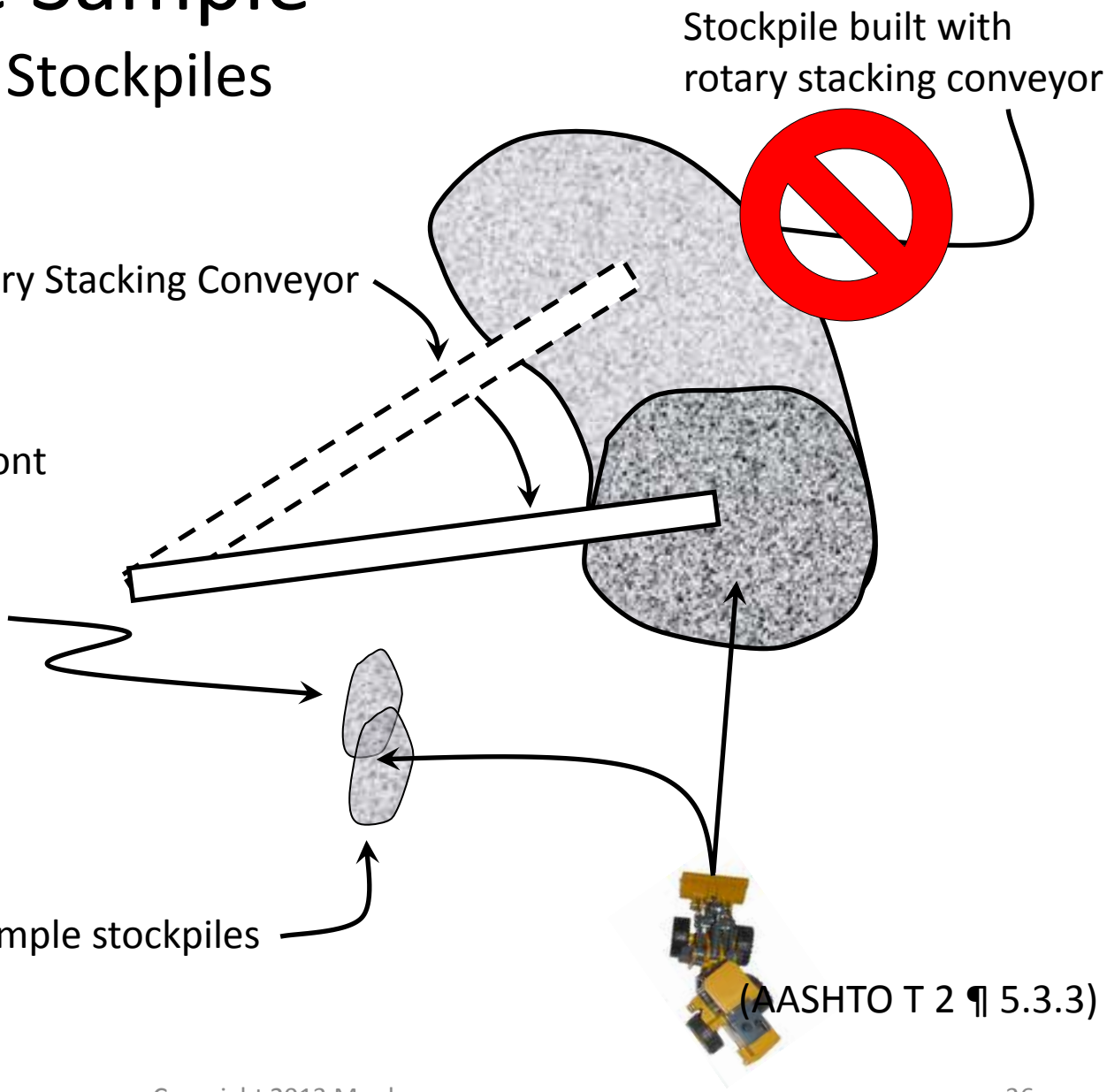



Bucket is usually 4 to 6 feet above stockpile floor and 'buried into the pile to compensate for coarse rock at surface

(AASHTO T 2 ¶ 5.3.3)

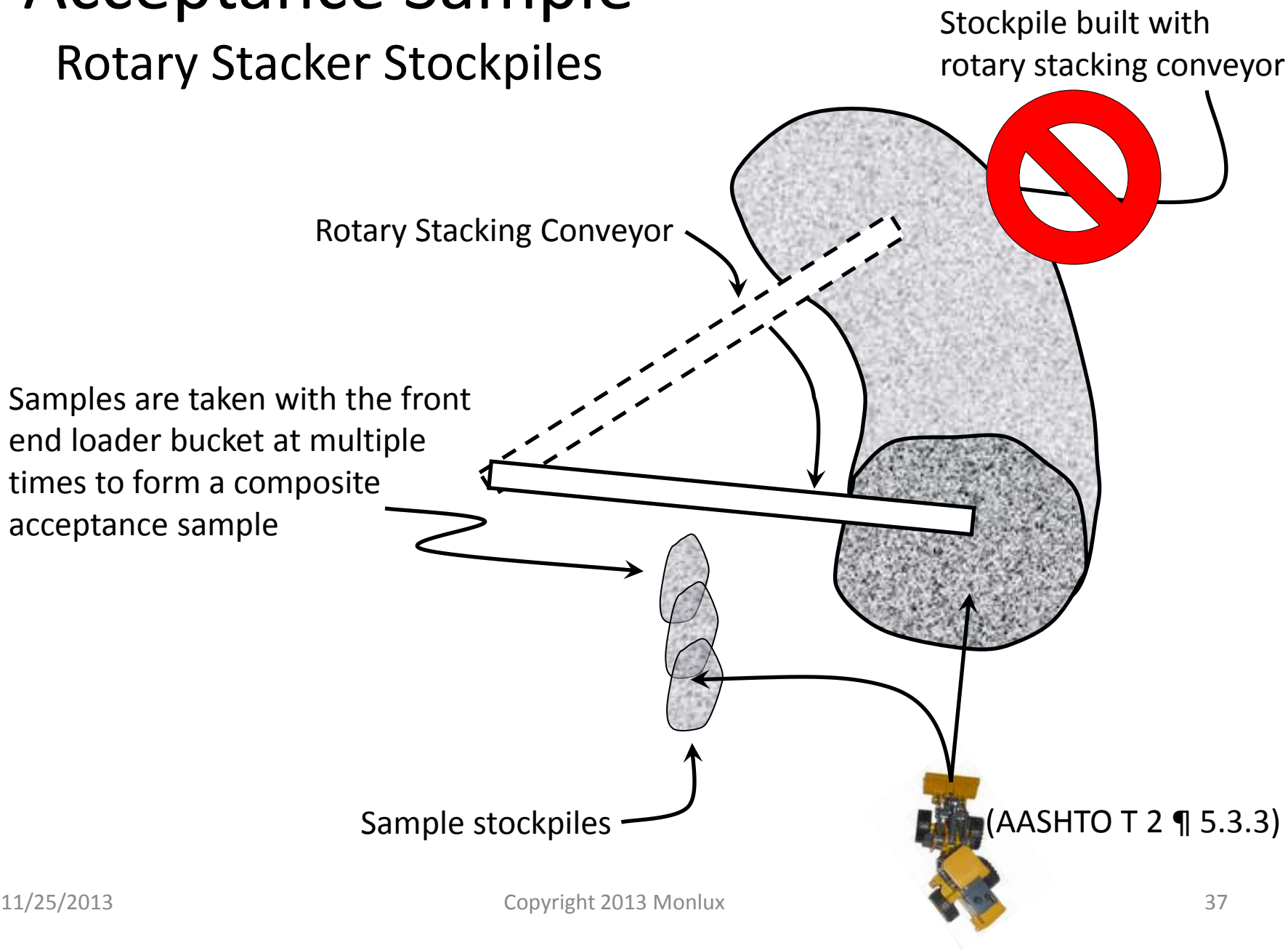
# Acceptance Sample

## Rotary Stacker Stockpiles



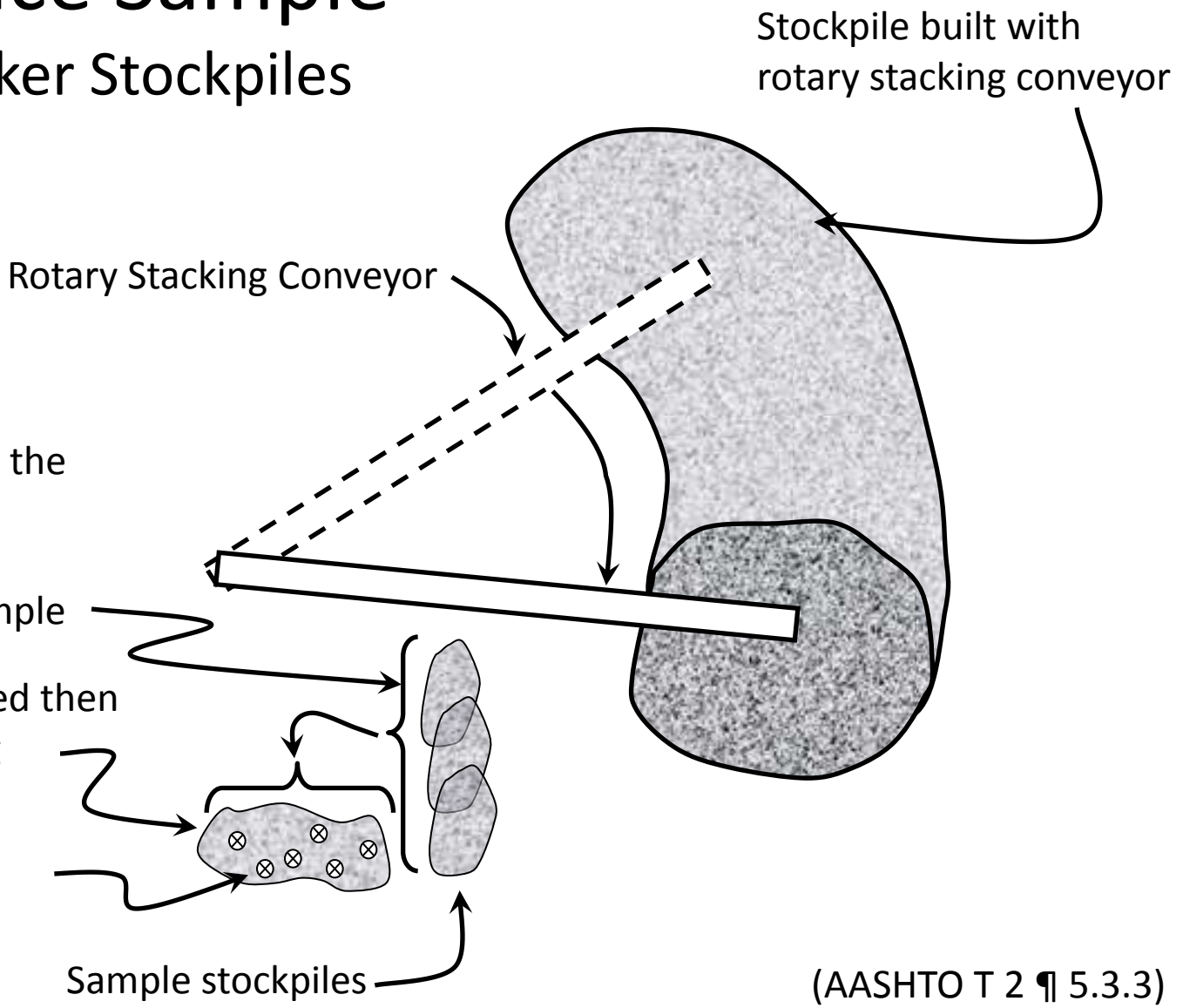
# Acceptance Sample

## Rotary Stacker Stockpiles



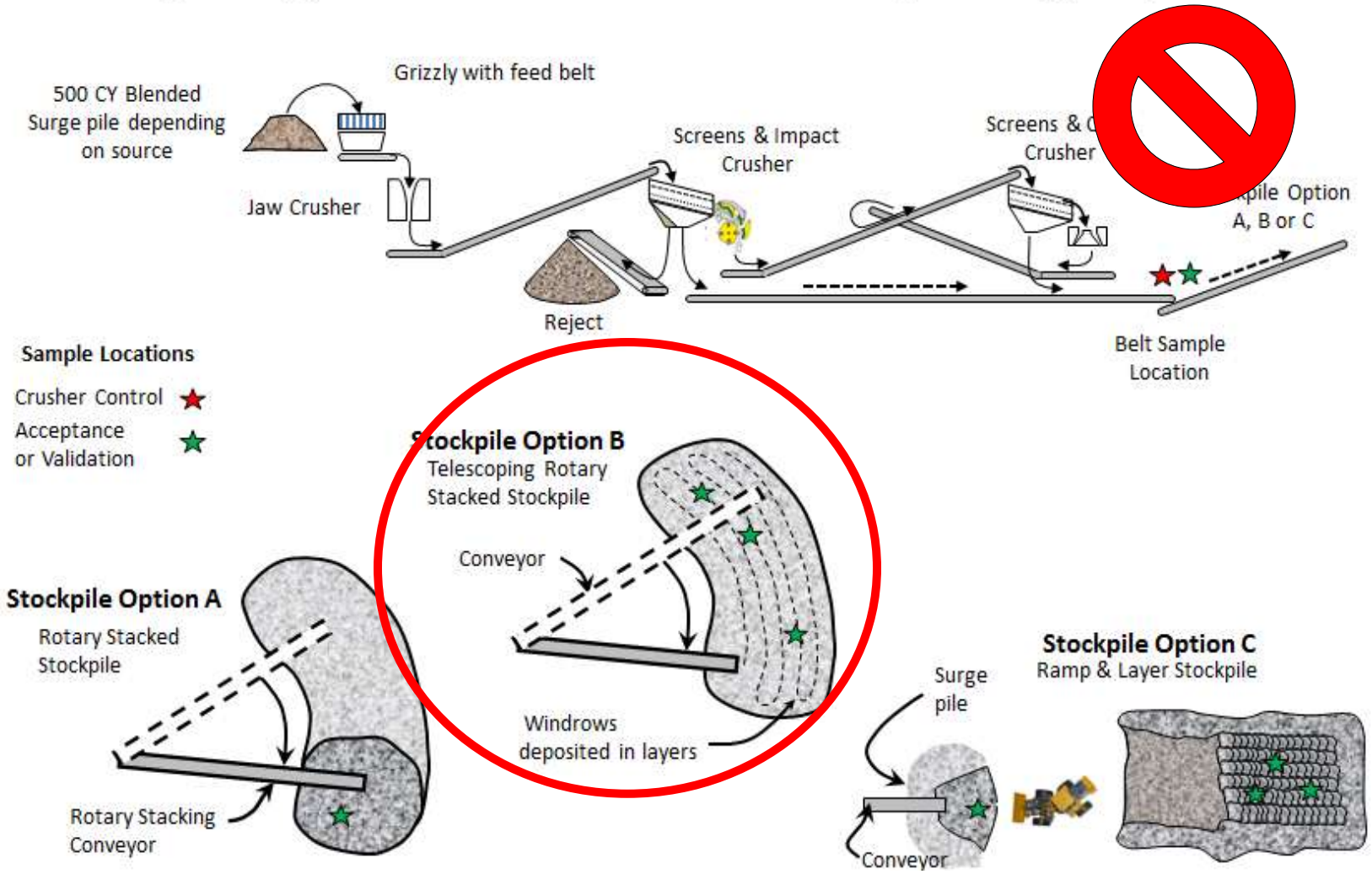
# Acceptance Sample

## Rotary Stacker Stockpiles



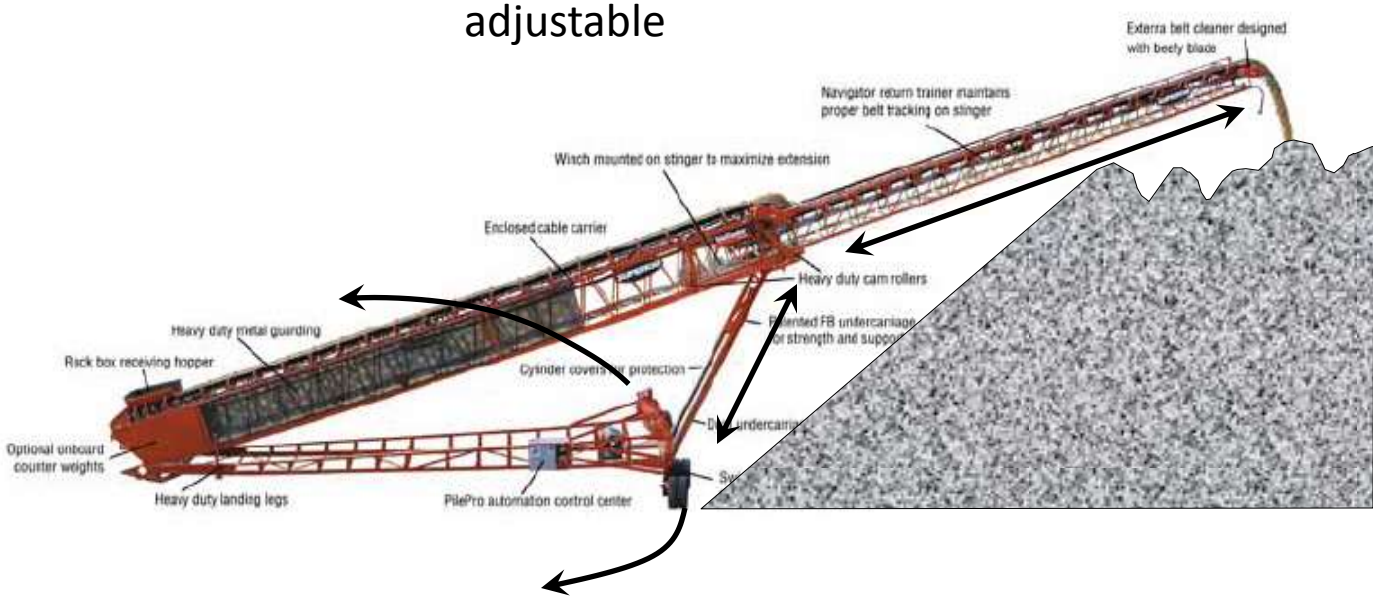

(AASHTO T 2 ¶ 5.3.3)

# Sampling Locations & Stockpiling Options



# Telescoping Radial Stacking Conveyor

Drop height is adjustable



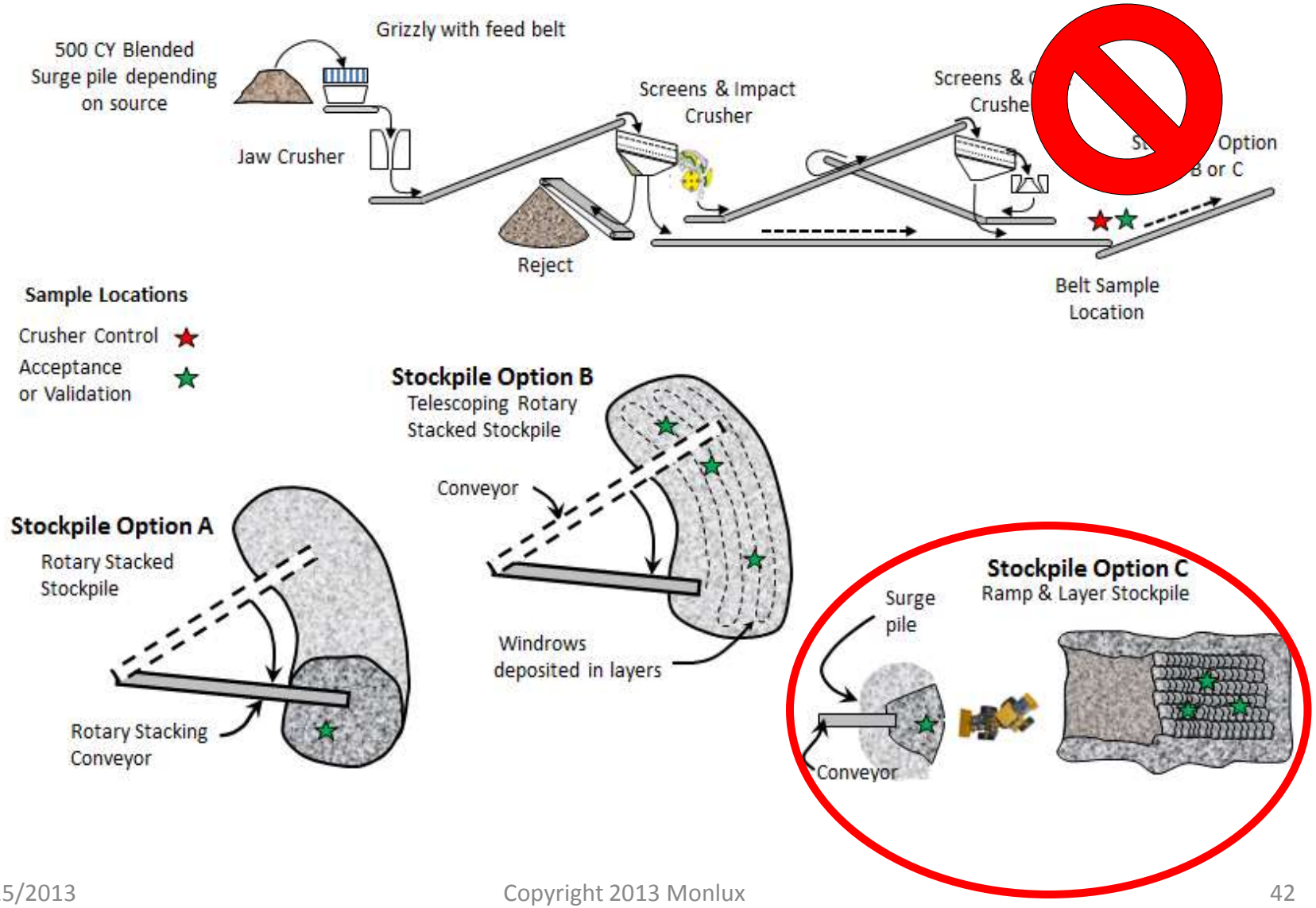
# Telescoping Rotary Stacking Conveyors

Cross H Crushing Contract, 2008, Johnson County WY

Do not allow windrows to flow over edge of pile

Coarse & fine windrows due to non-uniform crusher feed or when crusher stops and starts – be careful when sampling!

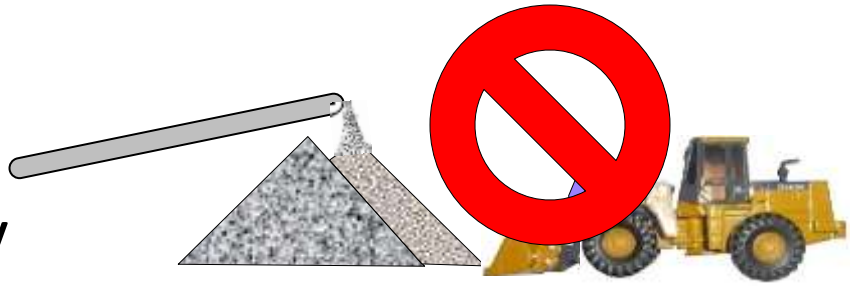
# Sampling Locations & Stockpiling Options



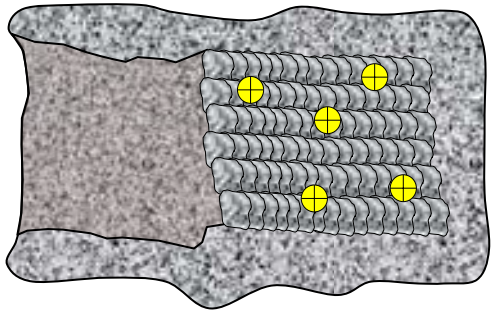
# Surge Pile Sampling

# Sampling ~ Ramp and Layer Stockpiles

- Surge Pile Sample
  - 3 or more bucket loads/day
  - Combine to one composite sample
  - Compare results with other samples

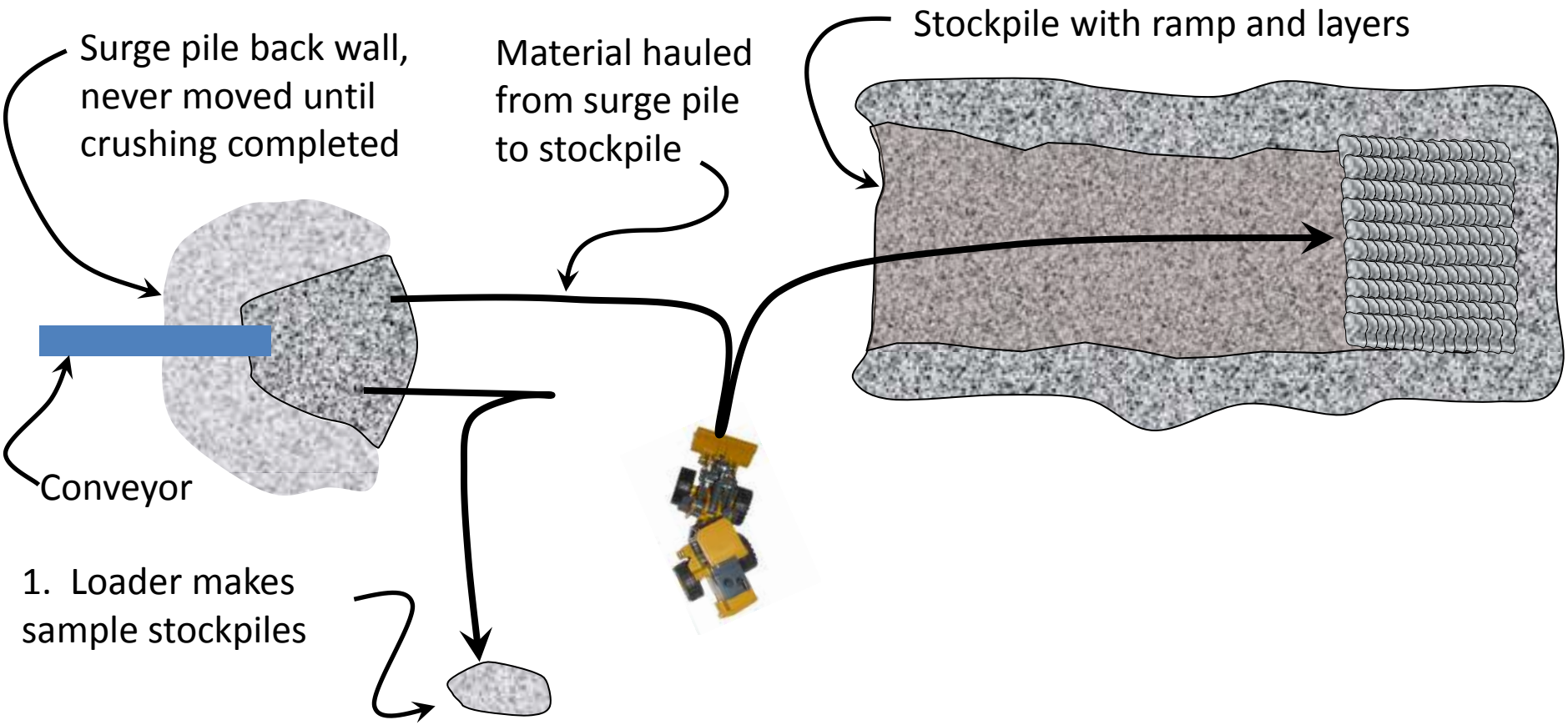


- Stockpile Sample
  - 3 or more locations/day
  - Combine to one composite sample
  - Compare results with other samples



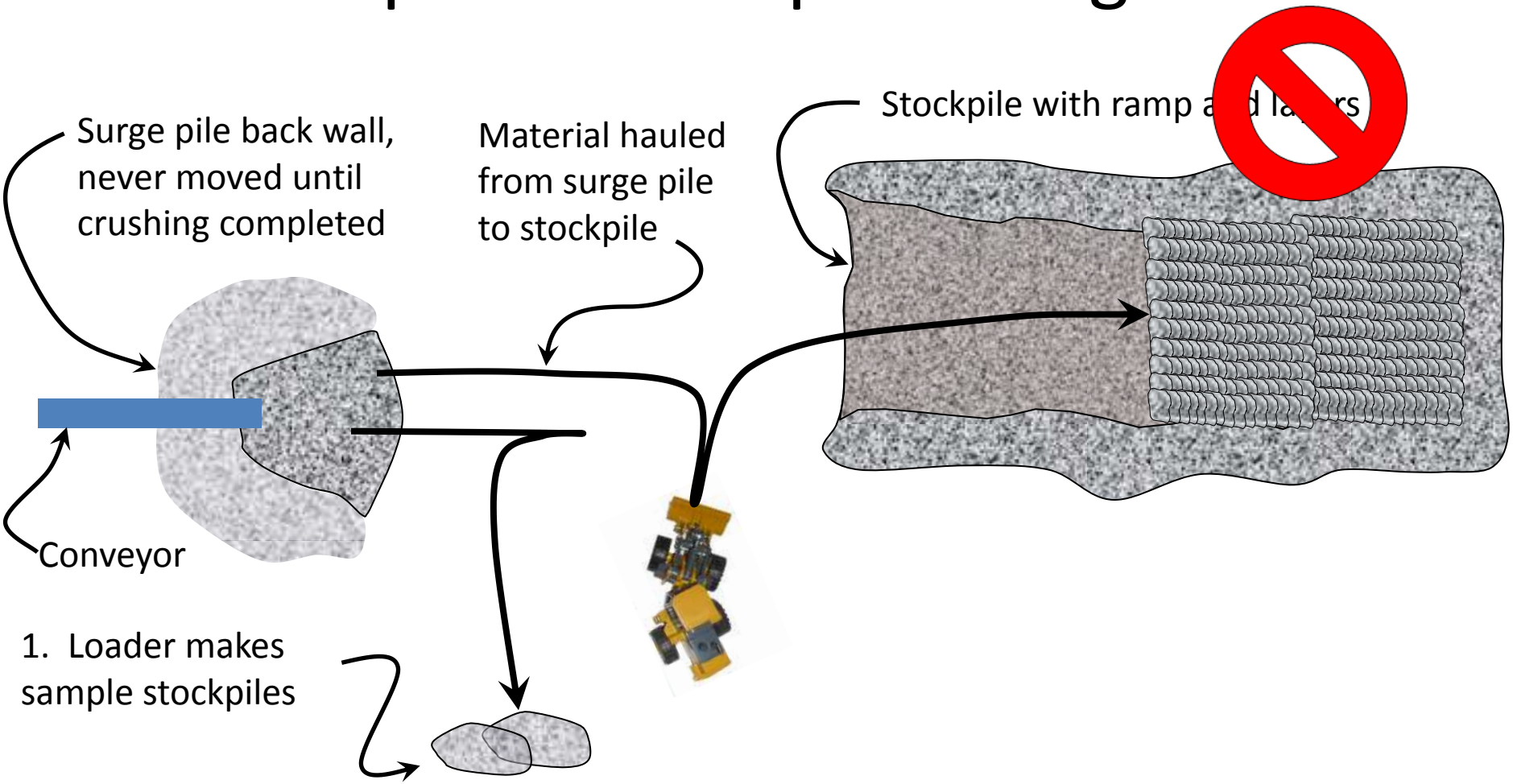
(AASHTO T 2 ¶ 5.3.3)

# Acceptance Sample ~ Surge Pile



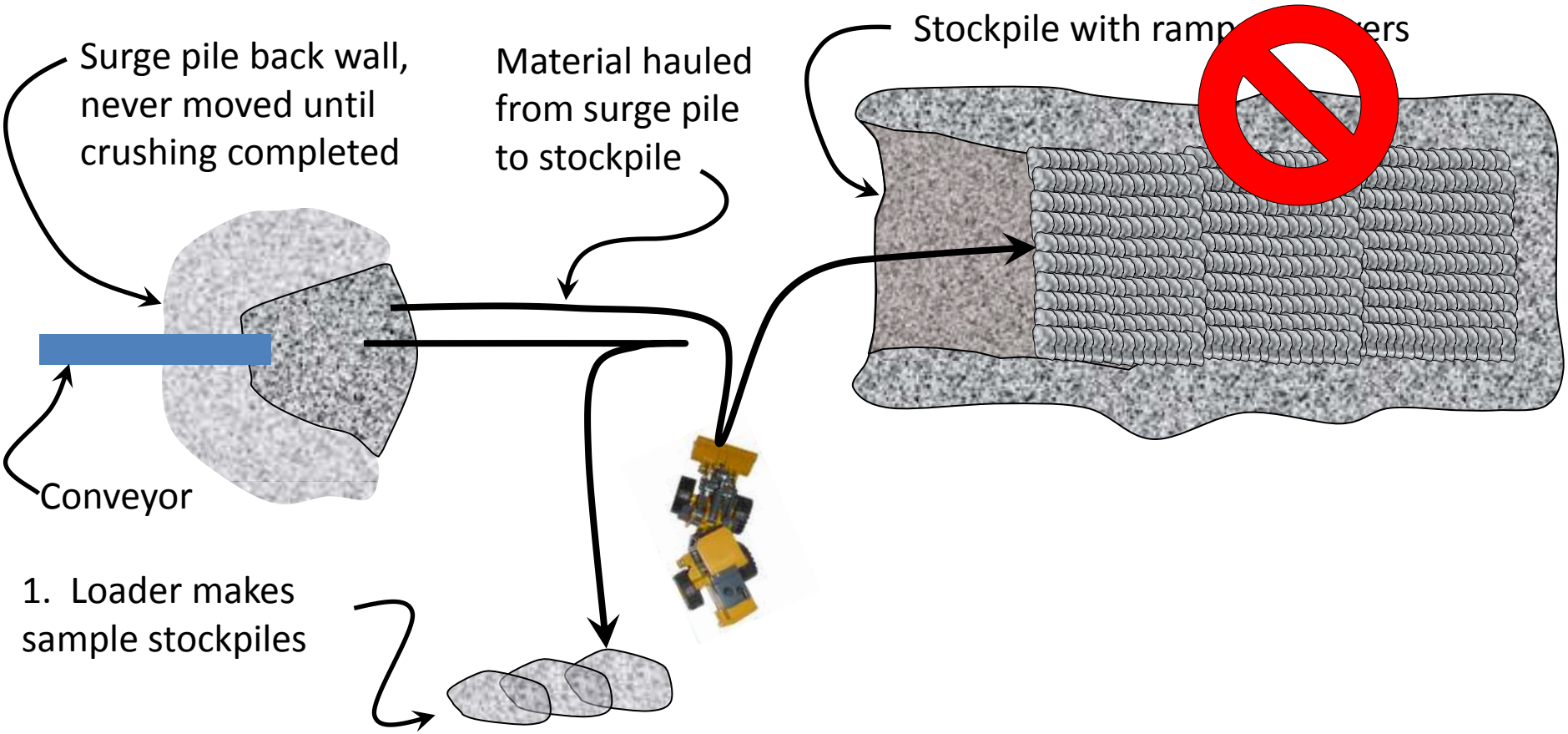

(AASHTO T 2 ¶ 5.3.3)

# Acceptance Sample ~ Surge Pile



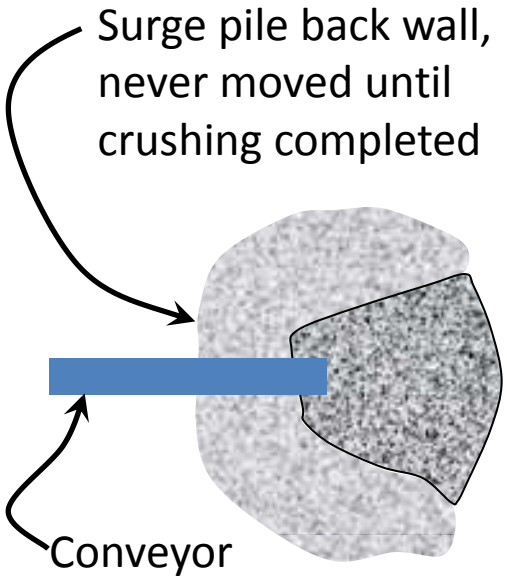

(AASHTO T 2 ¶ 5.3.3)

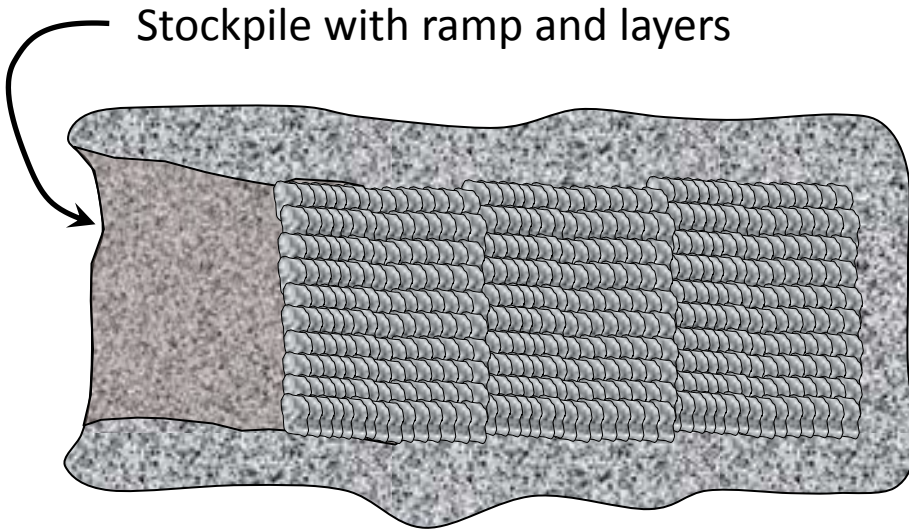
# Acceptance Sample ~ Surge Pile



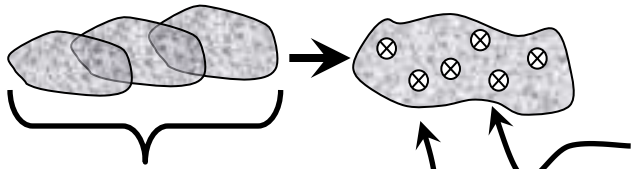

(AASHTO T 2 ¶ 5.3.3)

# Acceptance Sample ~ Surge Pile




1. Loader makes sample stockpile throughout workday

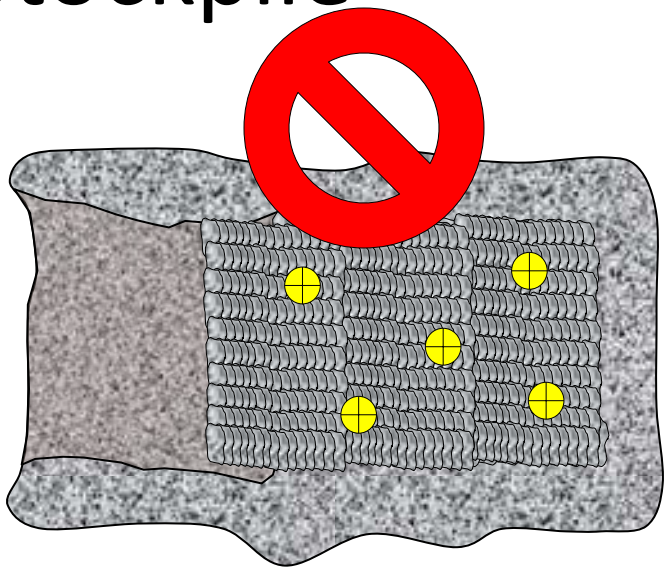


2. Sample stockpile is mixed then flattened prior to sampling

3. Sample locations from mixed and flattened sample stockpile

(AASHTO T 2 ¶ 5.3.3)

# Acceptance or Validation Sample ~ Ramp and Layered Stockpile



- Take samples from three or more locations each day
- Combine samples for form one composite sample for testing
- Testing
  - Acceptance samples – Test all
  - Validation Samples – test as many as necessary to confirm validity of Acceptance samples
- Retain sample splits for settling disputes

(AASHTO T 2 ¶ 5.3.3)

# Sampling Summary

| Type of Sample | Stockpiling Equipment & Stockpile Locati | | | | | |
|---|---|---|---|---|---|---|
| | Rotary Stacker | | Telescoping Rotary Stacker | | Ra[illegible]p ar[illegible] Layer St[illegible]ile | |
| Option | I | **II** | I | **II** | I | **II** |
| Acceptance Sample | Crusher Belt | **Under Discharge Belt** | Crusher Belt | **Windrows on Stockpile** | Crusher Belt | **Surge Pile** |
| Validation Sample | Under Discharge Belt | **Finished Stockpile Perimeter** | Windrows on Stockpile | **Finished Stockpile Perimeter** | Surge Pile | **Pile Layer on Stockpile** |
| | Finished Stockpile Perimeter | | Finished Stockpile Perimeter | | Pile Layer on Stockpile | |

**Sample frequency depends on CY to be crushed. 20 to 30 samples are normally adequate**

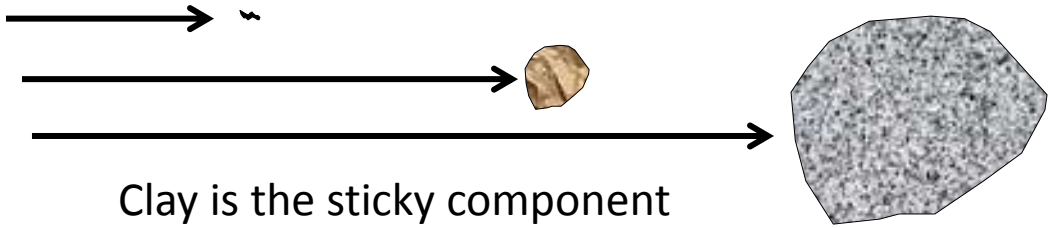
# Gravel Testing of Acceptance Samples

**Improvement Areas**
Type of Contract
Gravel Pit Investigation
Gravel Specs
Sampling
**Testing**
Quantity Measurement
Acceptance Options
Contract Admin

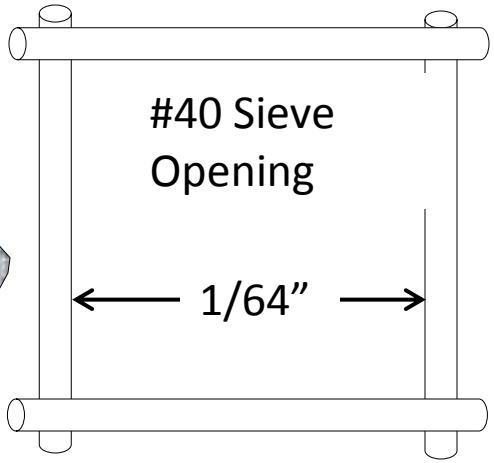
- Qualified lab
- Splitting:  Method, moisture content and sample size are critical
- Gradation
  - Washed sieve analysis for acceptance samples
- Plasticity Index
  - Wet Preparation required (to break down clumps)
  - Check sample available
- % Fracture:

# Plasticity Index (PI)

- **PI testing**
  - Hire qualified lab – require wet sample preparation, control samples are available to verify lab qualifications
- **What is PI**
  - A moisture content range when in a sticky condition
  - Higher PI material has more clay and is stickier
  - When sticky clays dry, they 'glue' gravel together
- **PI Test Sample** - minus #40 size mixture of:
  - Clay
  - Silt
  - Sand



Clay is the sticky component



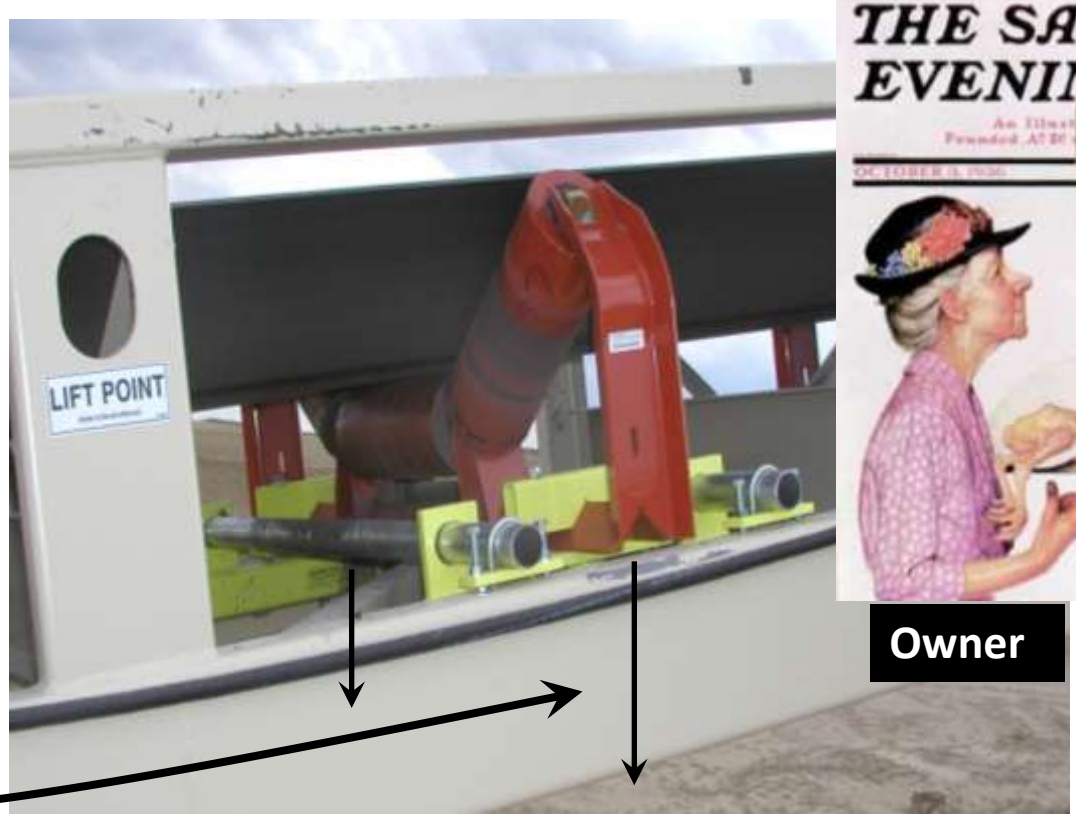

- **Changing PI in Gravel**
  - Pit PI won't change unless minus #40 mixture changes
  - Crushing & screening does not change #40
  - Change PI
    - Change amount of overburden or borrow that is plastic (PI ≈ 10 to 30)
    - Add very small amounts of Bentonite (PI of 350)

# Quantity Measurement Options

**Improvement Areas**
Type of Contract
Gravel Pit Investigation
Gravel Specs
Sampling
Testing
**Quantity Measurement**
Acceptance Options
Contract Admin

| Option | Description | Pro | Con |
|---|---|---|---|
| 1 | Tons payment by Belt Scales | Common | Scale calibration or manipulation problems, Paying for wet tonnage, **Tons not easily verified** |
| 2 | Tons payment by Loader Scales | Somewhat Common | |
| 3 (Suggested) | Ton payment based on 1.4 ton per CY, CY determined by stockpile measurement | Easily understood **Quantity easily verified by Owner** | Contractors may not like conversion but conversion known |
| 4 (Suggested) | CY determined by stockpile measurement | **Quantity easily verified by Owner** | Not industry standard |

# Belt Scales




Bungee cord locations for "calibration" purposes


**Owner** **Contractor**

"Black Box" or totalizer

**Conduct "zero" load test daily**

**Guide ¶ 4.3.5**

# Acceptance Options

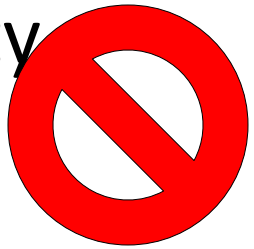
**Improvement Areas**
Type of Contract
Gravel Pit Investigation
Gravel Specs
Sampling
Testing
Quantity
Measurement
**Acceptance Options**
Contract Admin

| Options | Alternative | Pro | Con |
|---|---|---|---|
| 1 | All gradations must be in specs | Very Simple | Encourages bias s<br>Raises bids |
| 2 | Average of all gradation results must be in specs | Very Simple<br>Lowers bids | No control over v<br>Poor gravel performance<br>Half of gravel can be out of spec |
| 3 | Table for Incentives & Reductions on critical sieves | Simple approach | May not relate to gravel performance<br>Unfamiliar process<br>Raises bids |
| **4** | **Traditional DOT/FHWA Pay Factor** | **Disputes avoided<br>Familiar process<br>Better gravel** | **More funding needed for sampling & testing<br>Small Contractors raise bids** |

- Suggested Approach: Traditional DOT/FHWA Pay Factor
- Other Alternatives?

# Benefits of Pay Adjustment Systems

- Contractors more interested in quality
  - Pay reduction system
  - Incentive system
- Better quality gravel
- Lower life cycle costs
- Lower owner contract admin costs
- Easy system to implement



# Pay Factor Calculation

- Inputs
  - Gradation
  - Cubic yards
- Outputs:
  - Pay Factor represents percent payment
- Bonus Conditions
  - Average test result must be inside test band by several percent
  - Variation in test results must be minimized
- Tasks:
  - Evaluate PF after each test
  - Make crusher adjustments to maximize Payment
  - Never allow PF to get below 1.0 or 100%

# Pay Factor Excel Program

**Gradation, Pay Factor & Payment Results**

| | |
|---|---|
| Contract Price $/CY: | 6 |
| Cubic Yards: | 50000 |

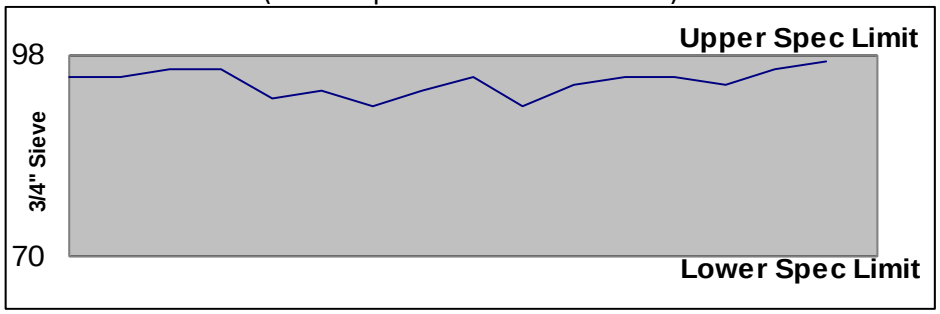
| | |
|---|---|
| Full Payment: | 300000.00 |
| Pay Factor: | 1.02 |
| Actual Payment: | 305999.99 |
| Bonus or Deduct: | 5999.99 |

| Sieve | Std. | 1" | 3/4" | 1/2" | #4 | #8 | #30 | #200 |
|---|---|---|---|---|---|---|---|---|
| Size: | mm | 25 | 19 | 12.5 | 4.75 | 2.36 | 0.6 | 0.075 |
| Spec Max | | 100 | 98 | 88 | 60 | 47 | 31 | 18.0 |
| Spec Min | | 97 | 70 | 58 | 36 | 25 | 12 | 10.0 |
| | 1 | 99 | 95 | 76 | 42 | 33 | 27 | 18.3 |
| | 2 | 100 | 95 | 73 | 39 | 31 | 26 | 17.0 |
| | 3 | 100 | 96 | 79 | 41 | 30 | 22 | 13.8 |
| | 4 | 100 | 96 | 78 | 43 | 33 | 24 | 15.0 |
| | 5 | 99 | 92 | 79 | 44 | 33 | 26 | 15.7 |
| | 6 | 100 | 93 | 77 | 39 | 26 | 17 | 10.5 |
| | 7 | 100 | 91 | 76 | 40 | 29 | 20 | 12.7 |
| | 8 | 99 | 93 | 74 | 39 | 29 | 21 | 13.7 |
| | 9 | 99 | 95 | 78 | 40 | 28 | 20 | 12.8 |
| | 10 | 100 | 91 | 73 | 38 | 29 | 21 | 13.0 |
| | 11 | 99 | 94 | 75 | 38 | 29 | 21 | 13.4 |
| | 12 | 100 | 95 | 76 | 42 | 29 | 20 | 12.1 |
| | 13 | 100 | 95 | 76 | 37 | 26 | 17 | 11.2 |
| | 14 | 99 | 94 | 80 | 41 | 29 | 20 | 13.6 |
| | 15 | 100 | 96 | 77 | 37 | 24 | 15 | 9.2 |
| | 16 | 99 | 97 | 79 | 42 | 29 | 20 | 12.6 |
| | 17 | | | | | | | |
| | 18 | | | | | | | |
| | 19 | | | | | | | |
| | 20 | | | | | | | |

| Sieve | Std. | 1" | 3/4" | 1/2" | #4 | #8 | #30 | #200 |
|---|---|---|---|---|---|---|---|---|
| Size: | mm | 25 | 19 | 12.5 | 4.75 | 2.36 | 0.6 | 0.075 |
| Average | | 100 | 94 | 77 | 40 | 29 | 21 | 13 |
| Range | | 1 | 6 | 7 | 3 | 9 | 12 | 9 |
| Std Dev | | 0.5 | 1.8 | 2.2 | 2.1 | 2.5 | 3.4 | 2.3 |
| $Q_u$ | | No PF | No PF | 5.275 | 9.352 | 7.025 | 2.961 | 1.995 |
| $Q_l$ | | No PF | No PF | 8.637 | 1.941 | 1.651 | 2.700 | 1.484 |
| Number of Samples | | | 16 | | | | | |
| $P_u$ (Table 106-1) | | No PF | No PF | 100 | 100 | 100 | 100 | 98 |
| $P_l$ (Table 106-1) | | No PF | No PF | 100 | 98 | 96 | 100 | 93 |
| P ($P_u$+$P_l$-100) | | No PF | No PF | 100 | 98 | 96 | 100 | 91 |
| **Pay Factor (Table 106-2)** | | **No PF** | **No PF** | **1.05** | **1.04** | **1.04** | **1.05** | **1.02** |
| Sieve Size | | 1" | 3/4" | 3/8" | #4 | #16 | #40 | #200 |

**Gradation Trend Plots**

(Out of Spec Results Not Plotted)



# Pay Factor Excel Program

**Gradation, Pay Factor & Payment Results**

| | |
|---|---|
| Contract Price $/CY: | 6 |
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| | |
|---|---|
| Full Payment: | 300000.00 |
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|---|---|---|---|---|---|---|---|---|
| Size: | mm | 25 | 19 | 12.5 | 4.75 | 2.36 | 0.6 | 0.075 |
| Spec Max | | 100 | 98 | 88 | 60 | 47 | 31 | 18.0 |
| Spec Min | | 97 | 70 | 58 | 36 | 25 | 12 | 10.0 |
| Sample Number | 1 | 99 | 95 | 76 | 42 | 33 | 27 | 18.3 |
| | 2 | 100 | 95 | 73 | 39 | 31 | 26 | 17.0 |
| | 3 | 100 | 96 | 79 | 41 | 30 | 22 | 13.8 |
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| | 5 | 99 | 92 | 79 | 44 | 33 | 26 | 15.7 |
| | 6 | 100 | 93 | 77 | 39 | 26 | 17 | 10.5 |
| | 7 | 100 | 91 | 76 | 40 | 29 | 20 | 12.7 |
| | 8 | 99 | 93 | 74 | 39 | 29 | 21 | 13.7 |
| | 9 | 99 | 95 | 78 | 40 | 28 | 20 | 12.8 |
| | 10 | 100 | 91 | 73 | 38 | 29 | 21 | 13.0 |
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| | 60 | | | | | | | |

| Sieve | Std. | 1" | 3/4" | 1/2" | #4 | #8 | #30 | #200 |
|---|---|---|---|---|---|---|---|---|
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| Range | | 1 | 6 | 7 | | 9 | 12 | 9 |
| Std Dev | | 0.5 | 1.8 | 2.2 | | | 3.4 | 2.3 |
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| $P$ ($P_u$+$P_l$-100) | | No PF | No PF | 100 | | | 100 | 91 |
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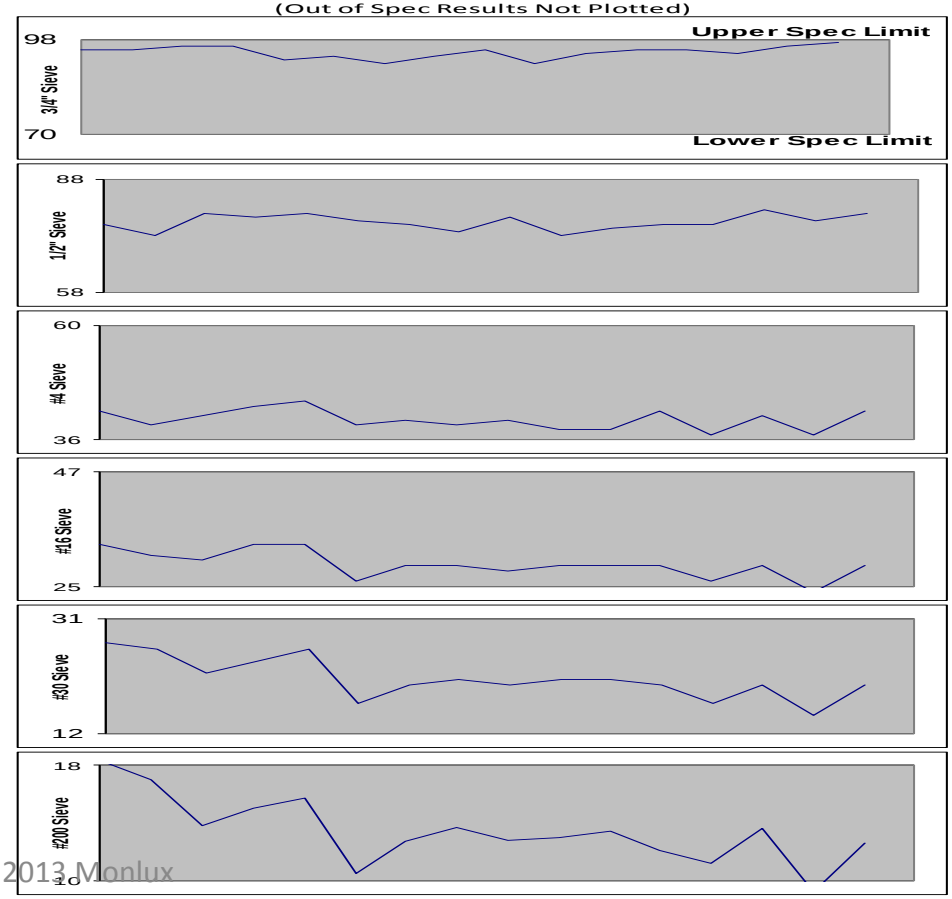
(Out of Spec Results Not Plotted)



# Contract Administration Suggestions

**Improvement Areas**
Type of Contract
Gravel Pit Investigation
Gravel Specs
Sampling
Testing
Quantity Measurement
Acceptance Options
**Contract Admin**

- Consider using “trust and verify” approach to inspection
- Respect your field of bidders
  - Enforce specs
  - Resisting changes without compensation.
- Take samples with contractor when possible
- Hold a detailed prework meeting with “on the ground” personnel

# Daily Quality & Quantity Assurance Tasks

| Tasks | Frequency, Timing | Contra | Owner |
|---|---|---|---|
| Belt Samples | As Desired by Contractor | | Check |
| Acceptance Sampling & Testing | (a) | Sampling | Testing |
| Validation Sampling & Testing | (b) | Sampling | Testing |
| Discuss payment | Daily | X | X |
| Cubic Yard Measurement | Survey stockpile floor and stockpile | Optional | X |
| Ton Measurement | Monitor Belt Scales **continuously** | X | X |
| Pay Factor Calculations | Daily | | X |

(a) Establish Acceptance Sample frequency (every 1000, 1500 or ? Tons) in contract, normally 20 to 30 tests per project are adequate

(b) Validation sampling frequency depends on stockpiling method

# Crushed Gravel Contract Changes

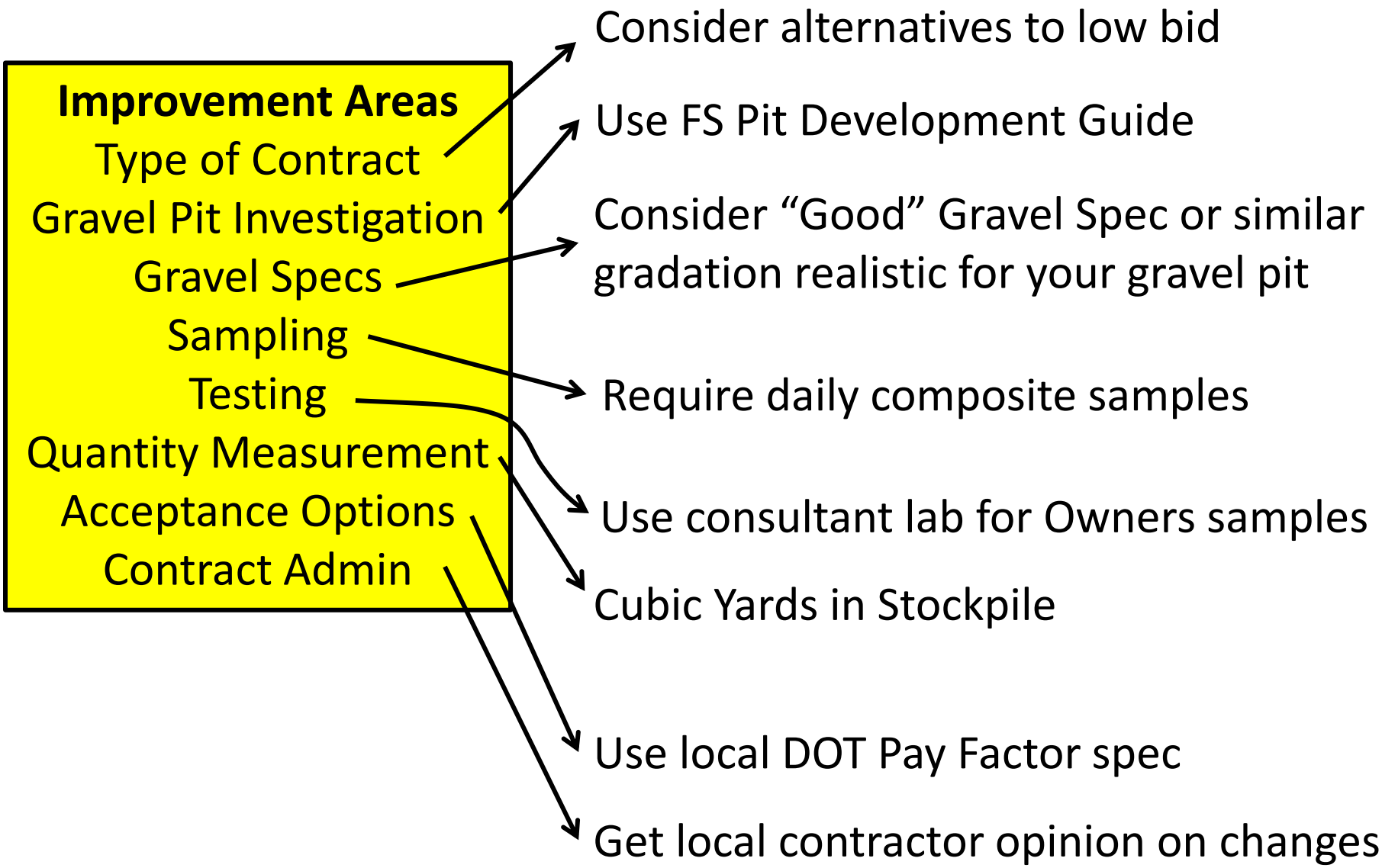
**(1) Pick and choose requirements that are suitable for your situation**

**OR**

**(2) Phase into changes as you become more comfortable with impacts on bids**

| Work Area | Crushing Contract Requirements to Consider (1) | Phase (2) | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| **Crusher Feed** | 500 CY crusher feed surge pile | | x | x | x |
| **Gradation & PI** | Max Size of ¾ or 1” | x | | | |
| | Max Size & #200 Indexed to PI | | x | | |
| | Max Size, #200 Indexed to PI, #4 & #30 sieve | | | x | x |
| | PI 4 to 9 or as appropriate | | | | x |
| **Sampling** | Periodic belt sampling by contractor while crushing | x | | | |
| | Composite sample using bucket loader | | x | x | x |
| | Validation samples from stockpiles | | | x | x |
| **Testing** | Testing by Contractor | x | | | |
| | Testing by Independent Consultant | | x | x | x |
| | Validation sample testing | | | x | x |
| **Payment** | Payment by belt or loader scales | x | | | |
| | Payment in stockpile by CY, use 1.4T/CY Conversion | | x | | |
| | Payment in stockpile by CY | | | x | x |
| | Statistical acceptance (FHWA & DOT) | | | | x |

# Contract Package Suggestions



# Westaskiwin County, Alberta

- Brian Anderson: Assistant Director of Public Works (**banderson@county.wetaskiwin.ab.ca 780-361-6244)**
- Gravel Road Traffic:  Heavy trucks from 2800 oil wells
- Annual Gravel Crushing: 100,000  CY for soft spot graveling
- Gravel Pits:
  - County owns 6 pits with 4.2 million CY reserves - $3/CY royalty payments
  - Silt reject can be up to 45%
- Contracting:  3 yr crushing contract award if $/CY less than  $/CY of 385,000 CY in stockpiles

# Westaskiwin County, Alberta

| Problems | Solutions |
|---|---|
| High Gravel Cost | Three year Crushing Contract<br>Always maintain large stockpile,<br>Sample & test new private sources |
| Payment by Tons | Payment by CY in stockpile<br>Measured by County |
| Poor Gravel Performance | #200 spec higher if silt, lower if clay<br>1 to 4 sieve tests/day by County Consultant |
| Gravel Loss and Too Much Blading | Chloride treatment,<br>Higher clay content<br>Clay content determined by road tests |
| Wet Season Road Damage | Commercial road use agreements/permits,<br>Law enforcement and portable scales |

# Sheridan County WY

- George Rogers:  County Project Manager (Retired) (crr1948@yahoo.com, 307-763-1003)
- Gravel Road Traffic:  50 to 600 ADT, mostly trucks
- County leases gravel pits & purchases crushed gravel
- Average annual usage for a 5 year period – 100,000T
- Primary Problems:
  - Gravel loss:  1” to 2” per year on truck routes
  - Poor performance: washboards, raveling, dusting, etc.
  - Amending out-of-spec gravel cost $2.75/T
- Changes (2008  to 2010)
  - Pit Investigation:  More extensive to assure gradation
  - Spec Changes:  #4 sieve 48 to 68%, #200 sieve 10 to 15%, Plasticity 4-12
  - Finer gradation  to improve performance w chloride

# Sheridan County, WY

- Contract Changes:
  - Correlation of labs at start up
  - Daily acceptance sampling & testing by county
  - Shut down if one acceptance sample out of spec
  - Belt Stacker dump height & valley depth <5 ft.
- Results:
  - Gravel Performance: Much less gravel loss, washboards, raveling, dusting and blading,
  - Gravel Costs
    - 2$/Ton in 2004 to 4$/Ton in 2010 – Good value for County
    - Investigation & crusher testing costs higher – Good value for County

# Johnson County WY

- Scott Pehringer:  Road and Bridge Foreman (rbsuper@johnsoncowy.us  307-684-2262)
- Gravel Road Traffic:  Heavy trucks during methane well development
- Annual Gravel Crushing: 75,000 CY for gravel replacement
- Gravel Pits:  BLM special use permits

# Johnson County Continued

- Contract Changes
  - Gradation: 1” max size, 8 sieve spec, 12 to 16% #200 if clayey
  - Quantity:  CY in stockpile, 90 to 110%
  - Segregation: telescoping rotary stacking conveyors
  - Sampling:  Daily sampling with front end loader
  - Testing:  County pays lab for acceptance sample tests
- Bid Increases:  Very minor
- Future Changes:
  - Require Dozer for pit mixing prior to crushing
  - Middle bid award
  - Acceptance by Pay Factor

# Primary Points of Presentation

- **Improve source investigations**
- **Pit plan notes**
- **Realistic specs, use of clay additives**
- **Sample your road gravels to determine good specs.**
- **Get local contractor input**
- **Mandatory prebid meeting**
- **Large daily composite samples**
- **Visit crusher every day**
- **Use Consultants for testing acceptance samples**
- **Payment by cubic yard in stockpile**

# Questions?