

# EcoPad

High Recycled Content  
In-situ Mixed  
Roller Compacted Concrete

Art Covi – We Energies  
Coal Combustion Products Team

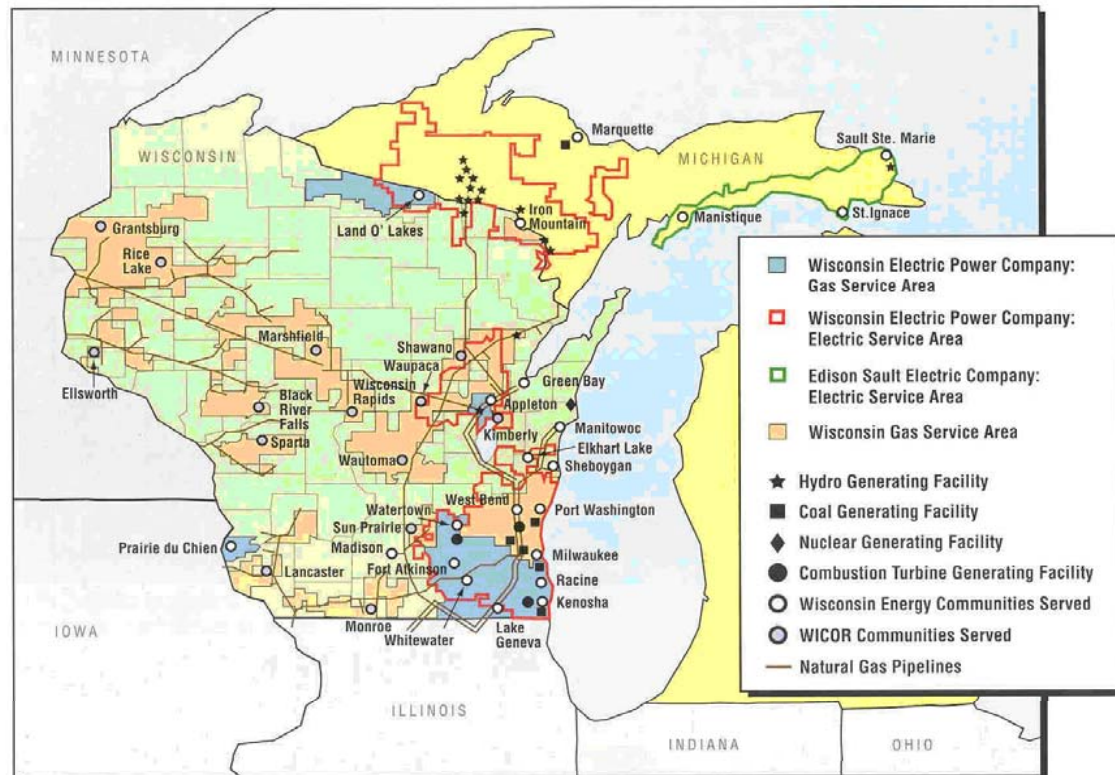
Anna Maria Workshop XIII  
Unconventional Concrete, Nov 2012



# We Energies

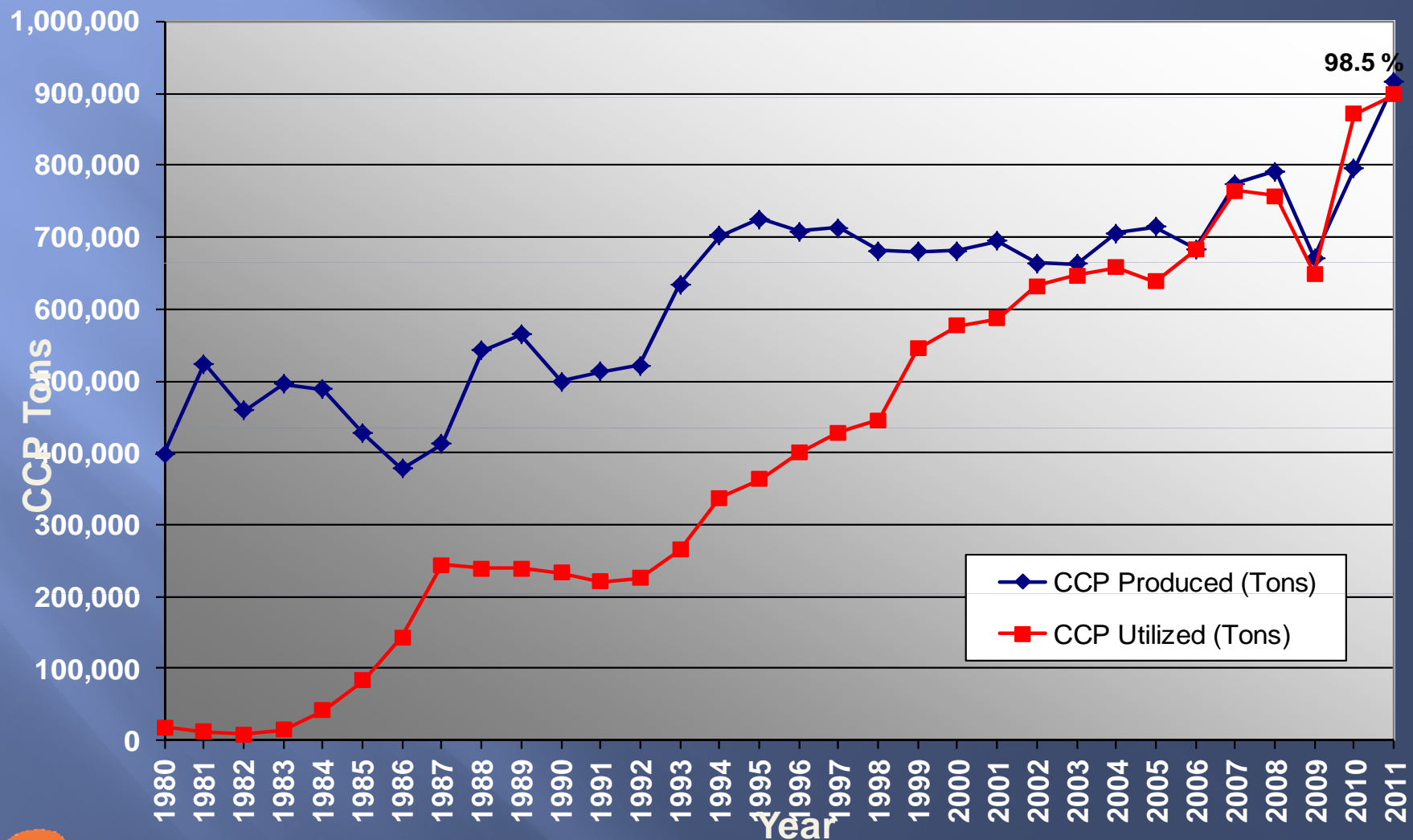
Serving over 1,000,000 Customers  
in Wisconsin & Michigan

## Combined Utilities Service Territories



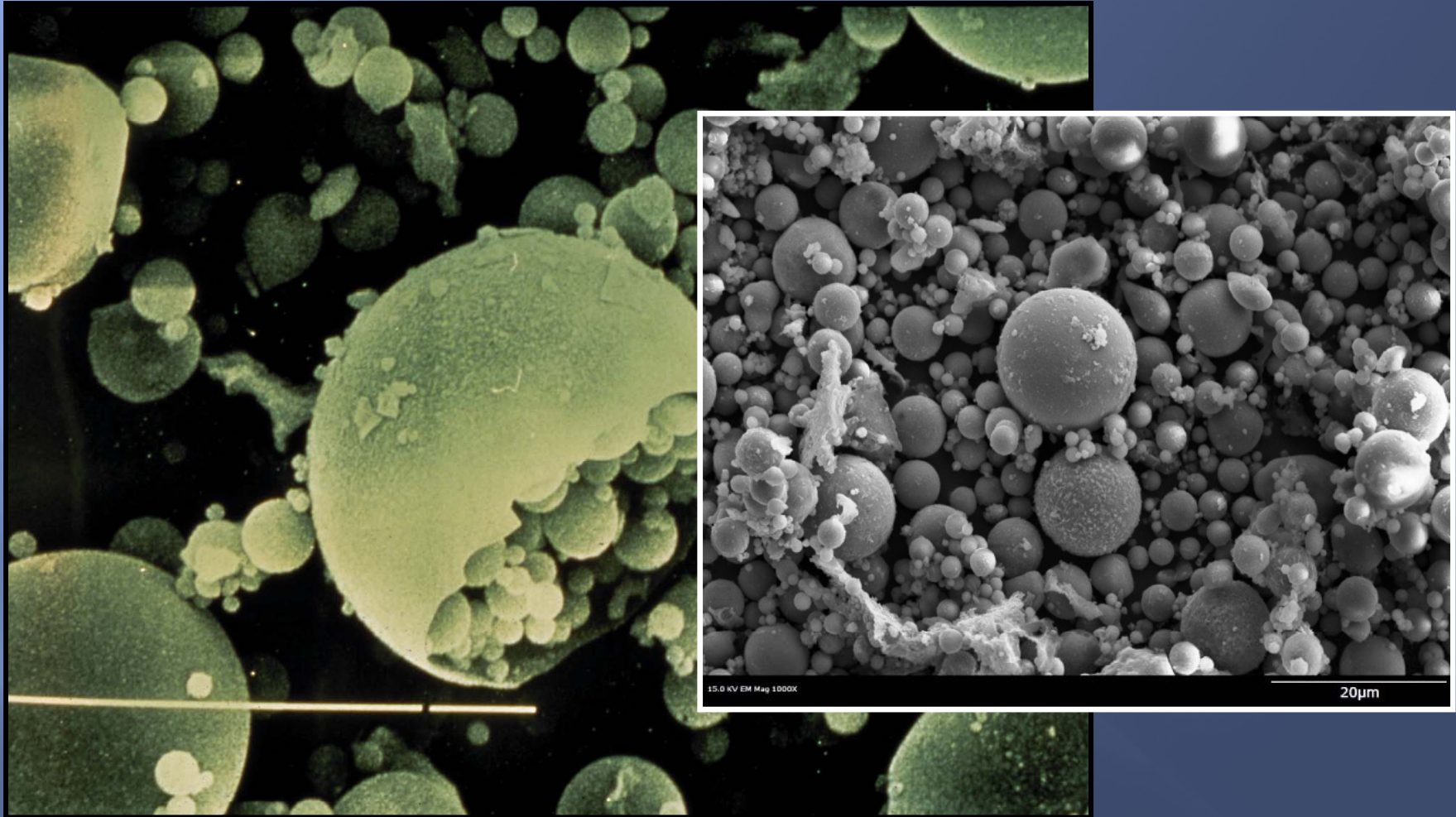
# CCP Utilization at We Energies

## CCP Production & Utilization





# Fly Ash for Construction





# Fine Aggregate: Bottom Ash “Sand”





# Power Plant Production



# Ash Recovery from Landfill





# MFSC EcoPad Installation

## We Energies Service Center



# EcoPad Concrete Process

- ✦ Grade and compact sub-grade
- ✦ Place 3" fine aggregate  
(Bottom Ash)
- ✦ Place 5" coarse aggregate  
(Recycled Concrete)
- ✦ Pulverize & mix aggregates



# EcoPad Concrete Process

- ✦ Place 50/50 fly ash & portland cement
- ✦ Pulverize full mix, add water as needed (optimum 9% to 13%)
- ✦ Grade and compact with vibratory sheepfoot roller
- ✦ Light grade and compact with smooth roller
- ✦ Water surface, seal & cure





# Place Bottom Ash Base Grade and Compact Paving Base



# Bottom Ash Engineering Properties: Moisture-Density

**Sample ID:** M11085  
**Material Description:** Black Bottom Ash  
**Sample Source:**  
**Proposed Use:** Engineered Fill  
**Reference Standards:** ASTM D4718, D2217, D422, D4318, C136/117

## Material Properties

**Natural Moisture:** - % > 3/4" sieve: 1  
**Liquid Limit:** - % > 3/8" sieve: 2  
**Plasticity Index:** - % > #4 sieve: 10  
**Specific Gravity:** 2.68 % < #200 sieve: 12  
(estimated)

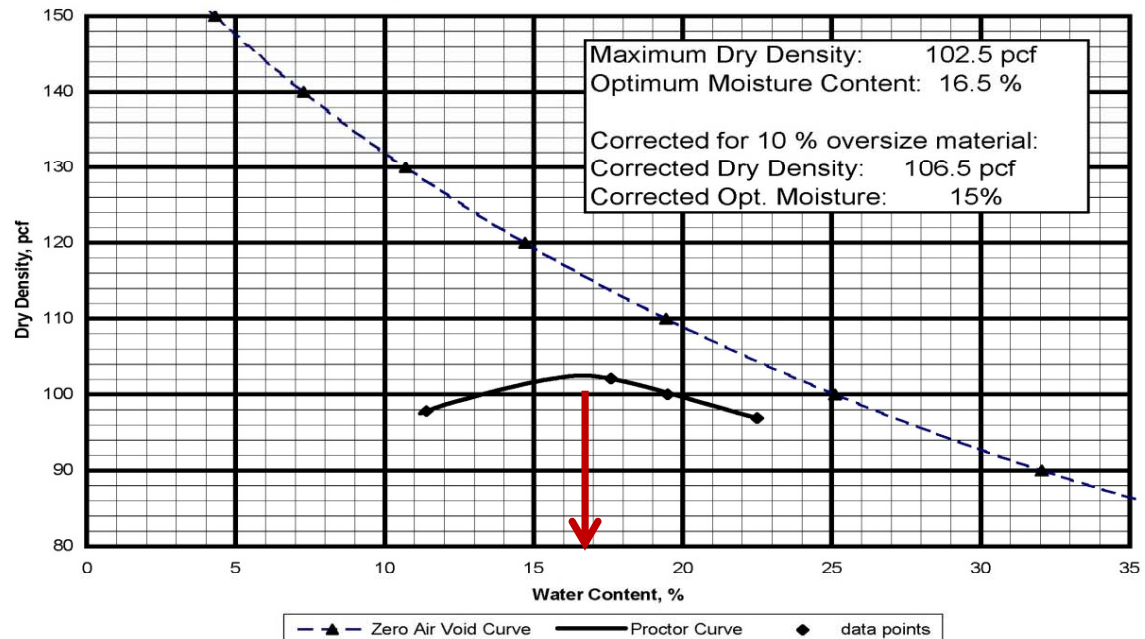
## QA / QC

**Sample Date:** 9/13/11  
**Sampled By:** client  
**Test Date:** 9/14/11  
**Tested By:** SH/JR  
**Reviewed By:** DA

## ASTM D1557 Method B

**Prep Method:** Moist

**Hammer Type:** Mechanical





# Place Bottom Ash & Recycled Concrete Aggregates

## Grade and Shape





# Pulverize & Mix Bottom Ash & Recycled Concrete Aggregates



# Grade & Shape Mixed Aggregates





# Transfer Fly Ash / Portland Cement Pneumatic Tanker Truck to Spreader Truck





# Place Fly Ash / Portland Cement

Apply Mixed Binders,  
or Spread by Lifts

Use Controlled Spreader



# Pulverize Full Mix

Fly Ash, Bottom Ash, Recycled Concrete

Add Water as Needed, 9% to 13% Optimum



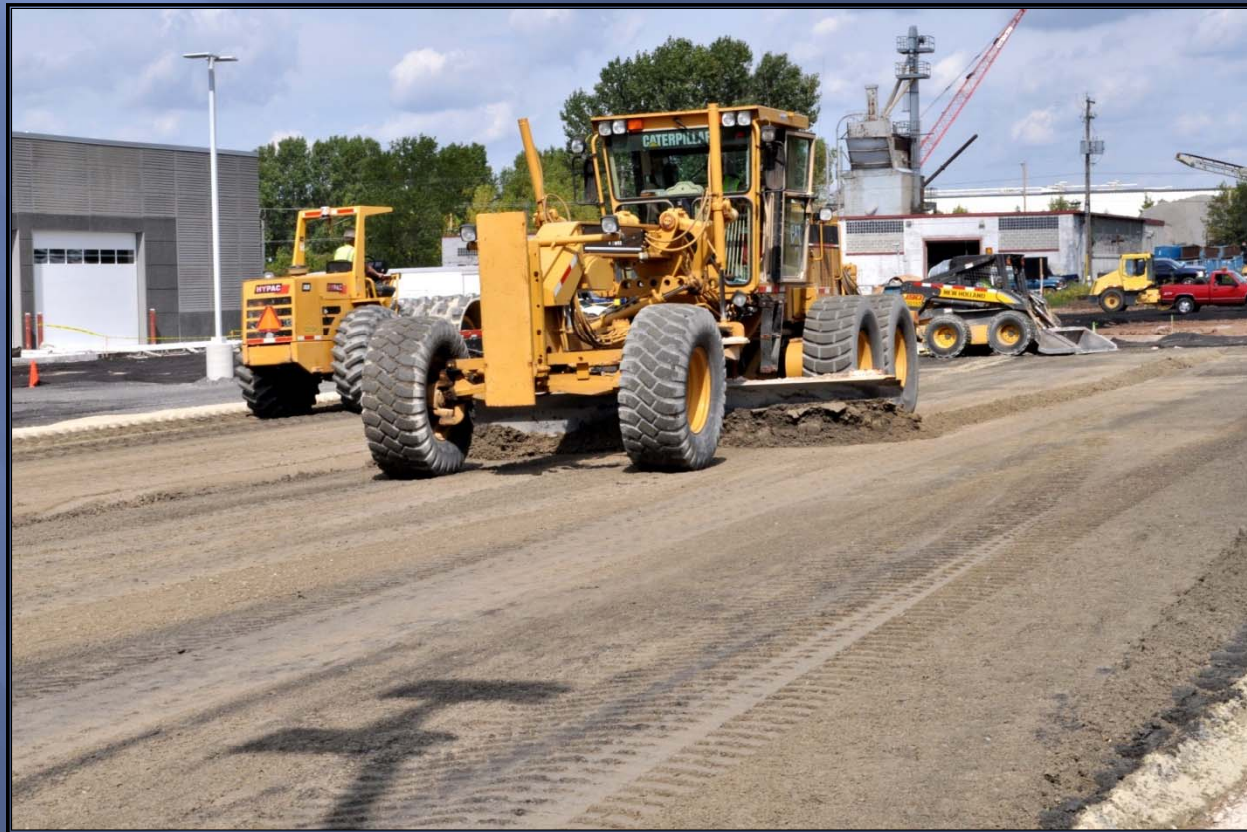


# Compact by Sheepsfoot Vibratory Roller



# Grade & Shape Fully Mixed Concrete

Match Specified Grades & Slopes



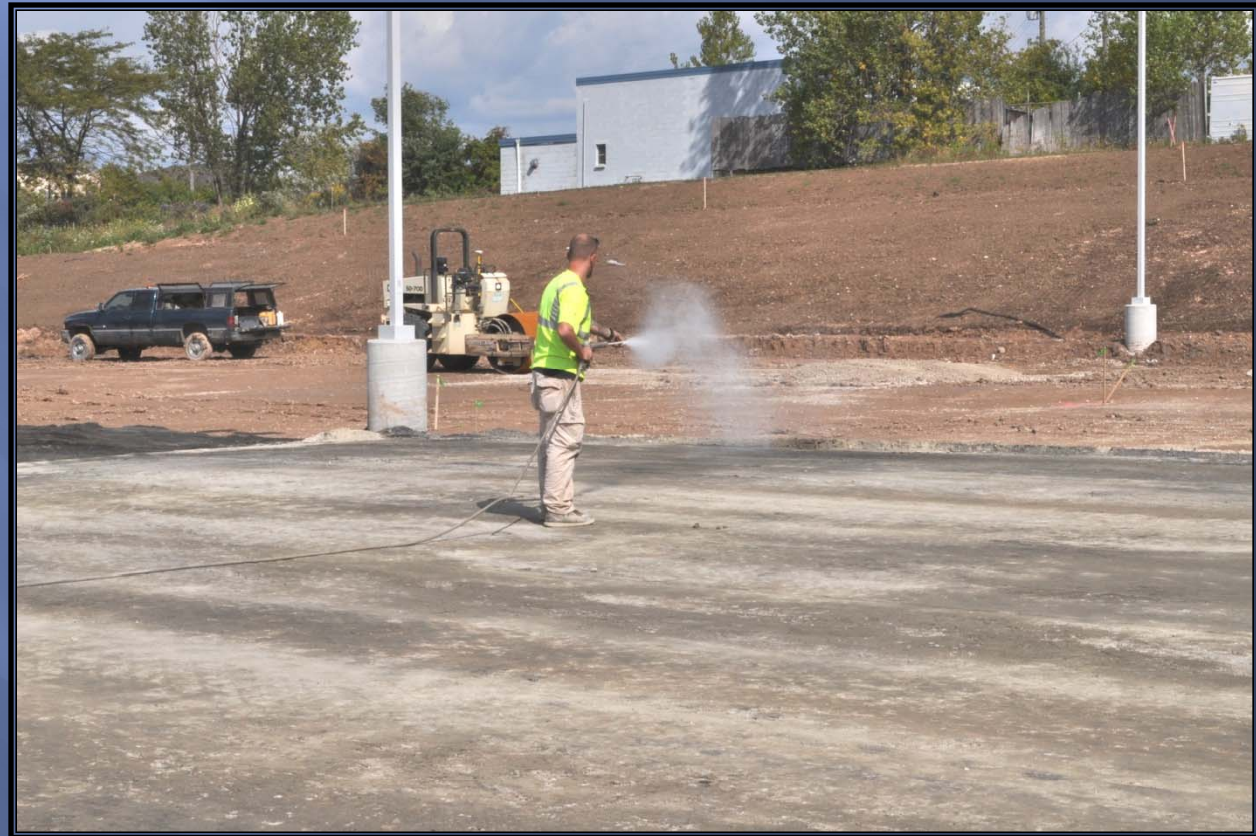


# Smooth Finish Roller, Non-Vibratory



# Surface Water

As Needed (Weather) .... Light Application, Low Velocity May apply plastic cover.





# Heavy Point Loads & Trucking Traffic





# Exposed Aggregate, Weathers to Solid Surface





# Final Appearance

Exposed Aggregate Surface, Rustic & Utilitarian  
Control Joints, if Needed.....for Esthetics





# Coring and Strength Tests MFSC

3,000 psi to 4,200 psi  
Avg 3,500 psi





# Company Projects:

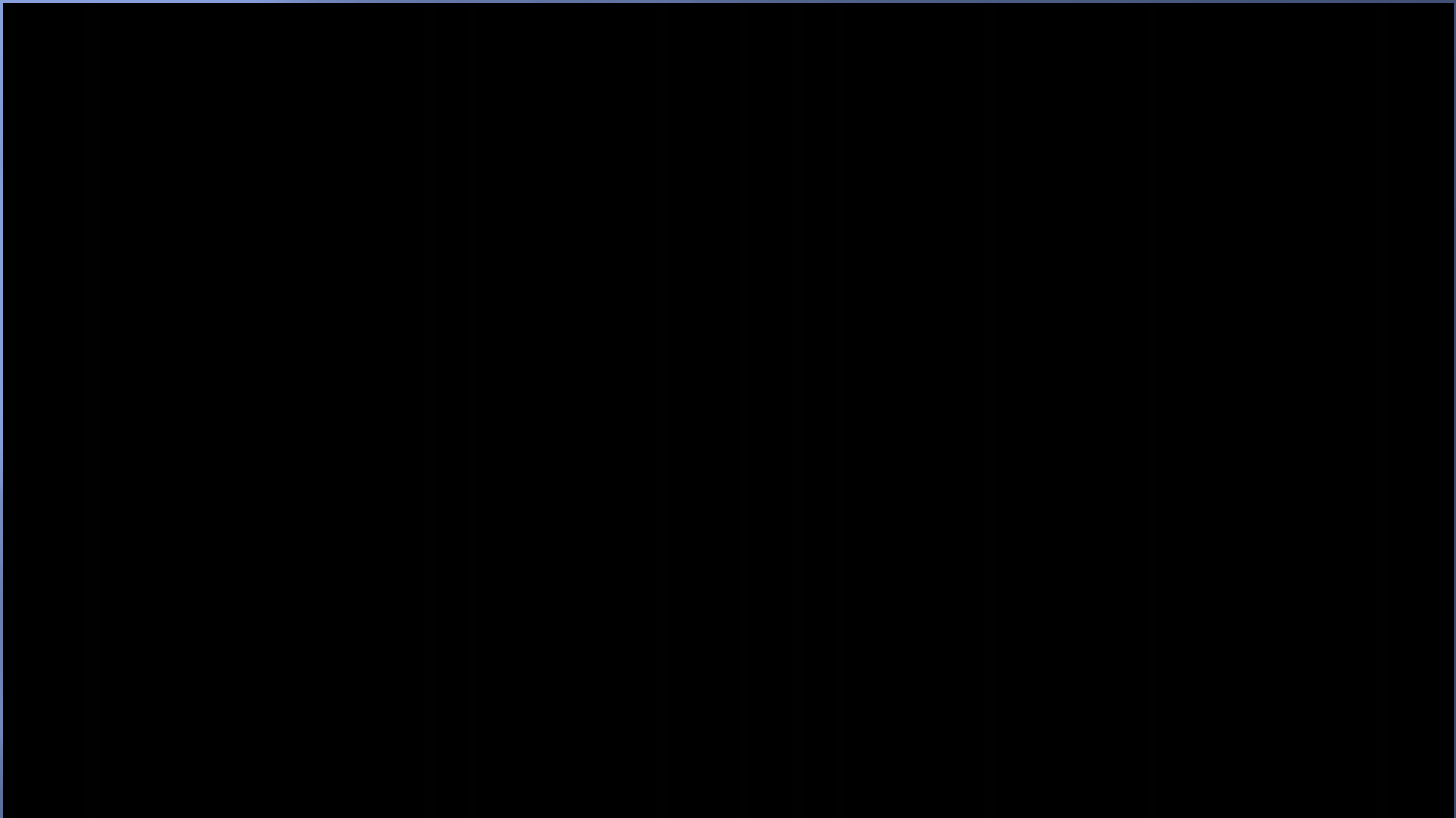
DOMTAR Biomass Power Plant

Fuel Storage Bldg EcoPad, using Fly Ash & Recycled Materials

Fly Ash in Concrete for Foundations and Structures



# Work Sequence





# EcoPad Installation



# Similar Construction Methods

Encapsulated or ???





# Soil Stabilization

Increase the structural capacity of sub-grades or poor soils using cementitious fly ash



# Full Depth Reclamation

## Cold In-Place Recycled Pavement

Better road bases using fly ash binder for recycling asphalt or concrete pavements, alternative to conventional dig/haul/fill approach.





# Full Depth Reclamation Typical Process

- ❑ Initial pavement pulverization
- ❑ Grading
- ❑ Fly ash binder addition: 5% to 15%
- ❑ Repulverization / mixing
- ❑ Add water: optimum typically 6% to 9%
- ❑ Reshaping and compacting
- ❑ New HMA or concrete wearing surface

# Mix Design:

Fly Ash – Class C	0.3 Tons /CY	<u>Application Rate:</u> 133 lbs/SY or 2.5 inch lift (loose)
Portland Cement	(Pre-Mixed) 50% / 50%	
Bottom Ash	0.6 Tons/CY	3 inch lift
Recycled Concrete	1.0 Tons/CY	5 inch lift
Water	9% to 13%	In-Situ, Add as Needed





# Costs for Roller Compacted, In-Situ Mixed EcoPad Concrete

Cost Range for 8" EcoPad:

Approx. \$2.00/SF to \$3.00/SF (Excluding Base)

Project Size:

Should be > 30,000 SF....

Larger Scale Increases Savings

Cost Variables:

Cost of Ash, Recycled Concrete,  
Bottom Ash Transportation / Mobilization

Amount of Binder and Mix Design

Availability of Pre-Blended Binder

(Can be Blended On Site)

Slab Thickness

8 inch Nominal, 12 inch Practical Max



# EcoPad Performance





# Pleasant Prairie Power Plant EcoPad – 2006



# Cementitious Materials

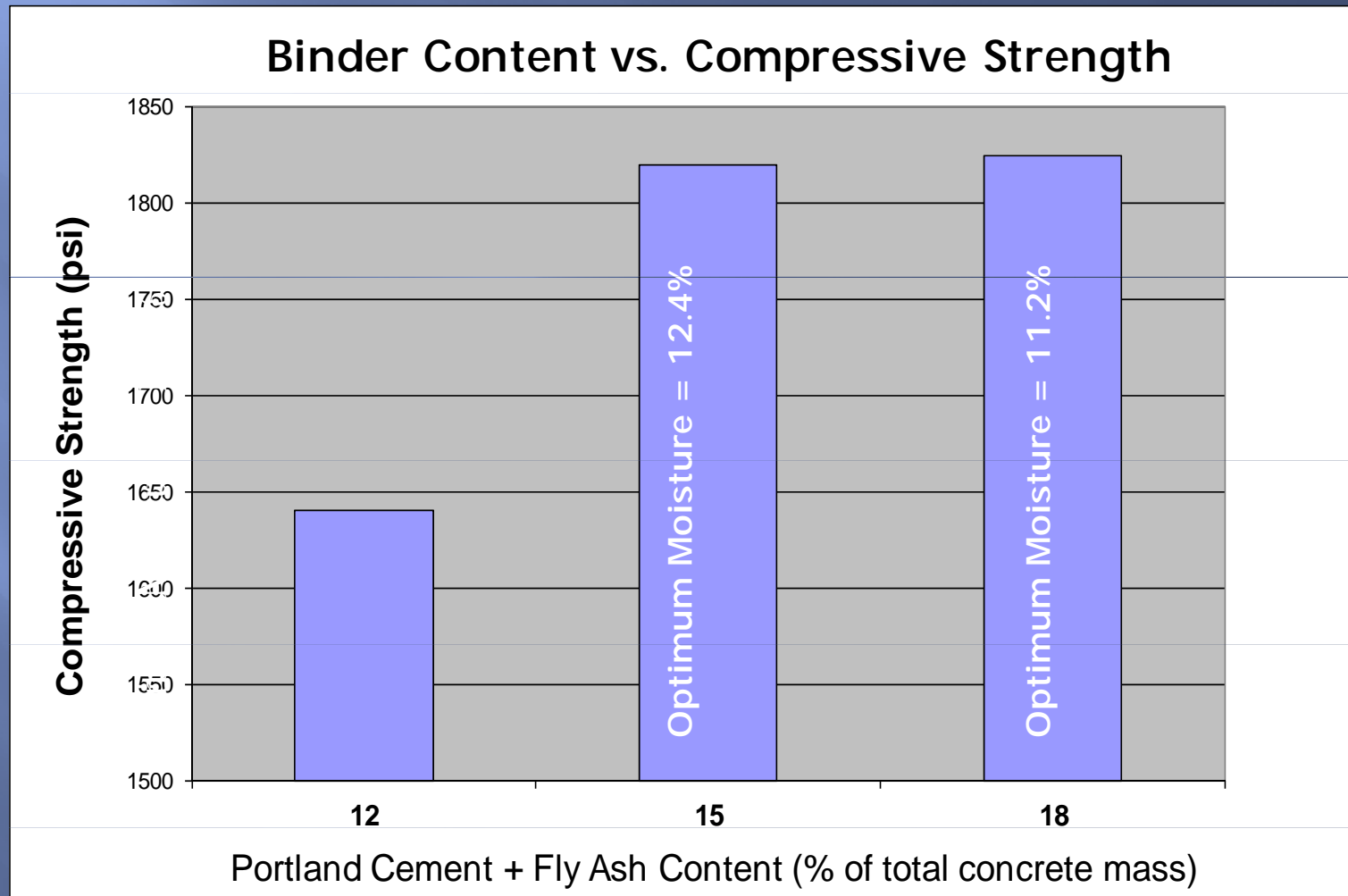
Chemical Data	Class C Fly Ash	Portland Cement Type I / II
SiO <sub>2</sub> %	40.3	20.7
Al <sub>2</sub> O <sub>3</sub> %	18.9	4.8
Fe <sub>2</sub> O <sub>3</sub> %	5.2	2.7
SiO <sub>2</sub> + Al <sub>2</sub> O <sub>3</sub> + Fe <sub>2</sub> O <sub>3</sub> %	64.5	28.2
CaO %	21.6	65.4
MgO %	3.8	2.5
SO <sub>3</sub> %	1.9	2.4
LOI %	0.4	1.6
Na <sub>2</sub> O %	1.8	-
K <sub>2</sub> O %	1.2	-
Available Alkalis (as equivalent Na <sub>2</sub> O%)	1.3	0.5



# Cementitious Materials

Physical Data	Class C Fly Ash		Portland Cement
Fineness, retained on #325 sieve%	13.6		5.3
Specific Gravity	2.52		3.15
Strength Activity Index 7 day (% of control)	106		

# Optimal Binder Performance





# Moisture – Density Relationship for EcoPad

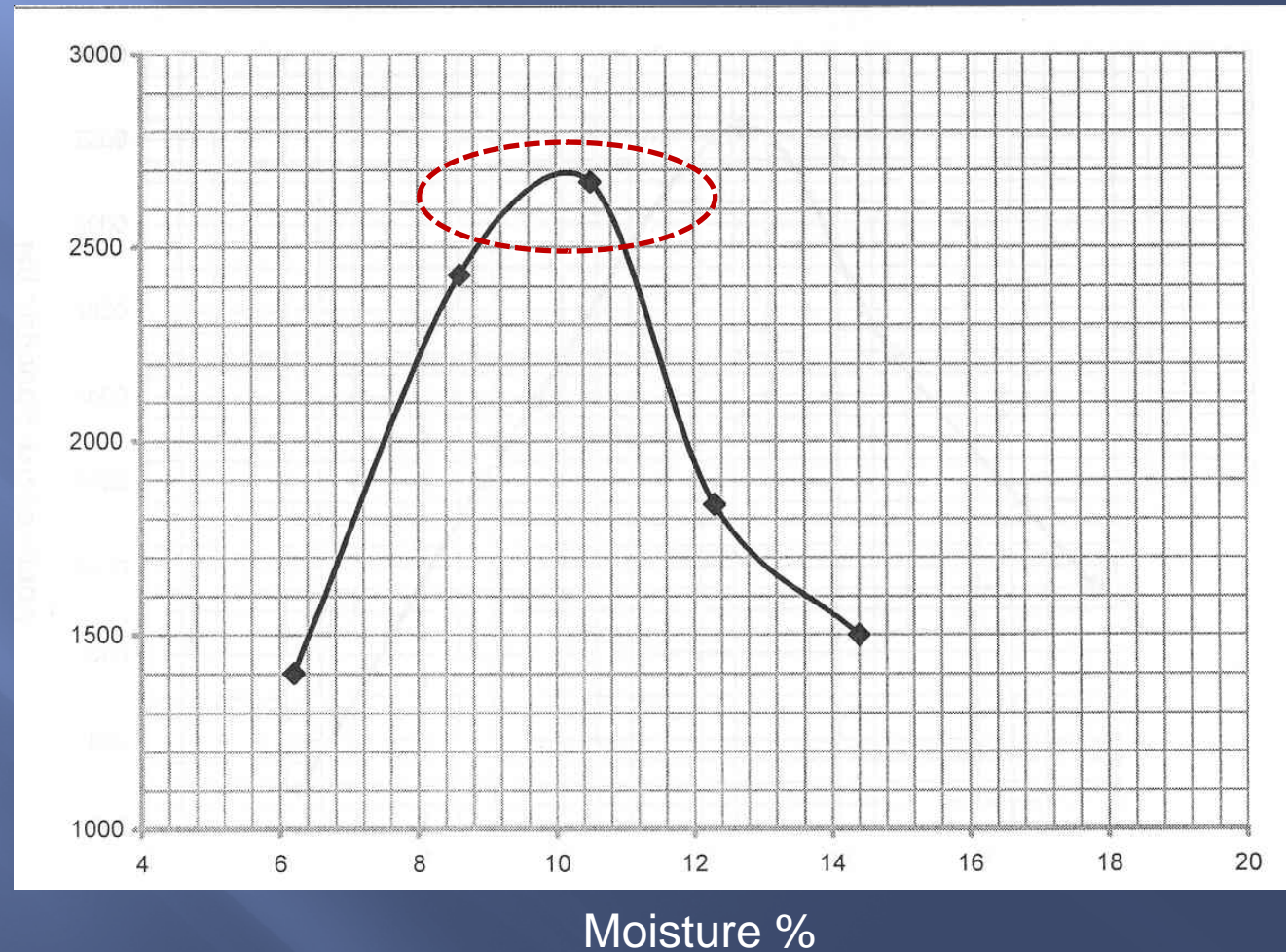
15% 50FA/50PC + 5" RC + 3" BA



# Moisture - Strength Relationship for EcoPad

15% 50FA/50PC + 5" RC + 3" BA

Compressive Strength (psi at 7 days)





# Field Testing QA /QC



Molded Cylinders  
for Compressive Strength  
(Standard Proctor)

Moisture & Density



# Field QA / QC

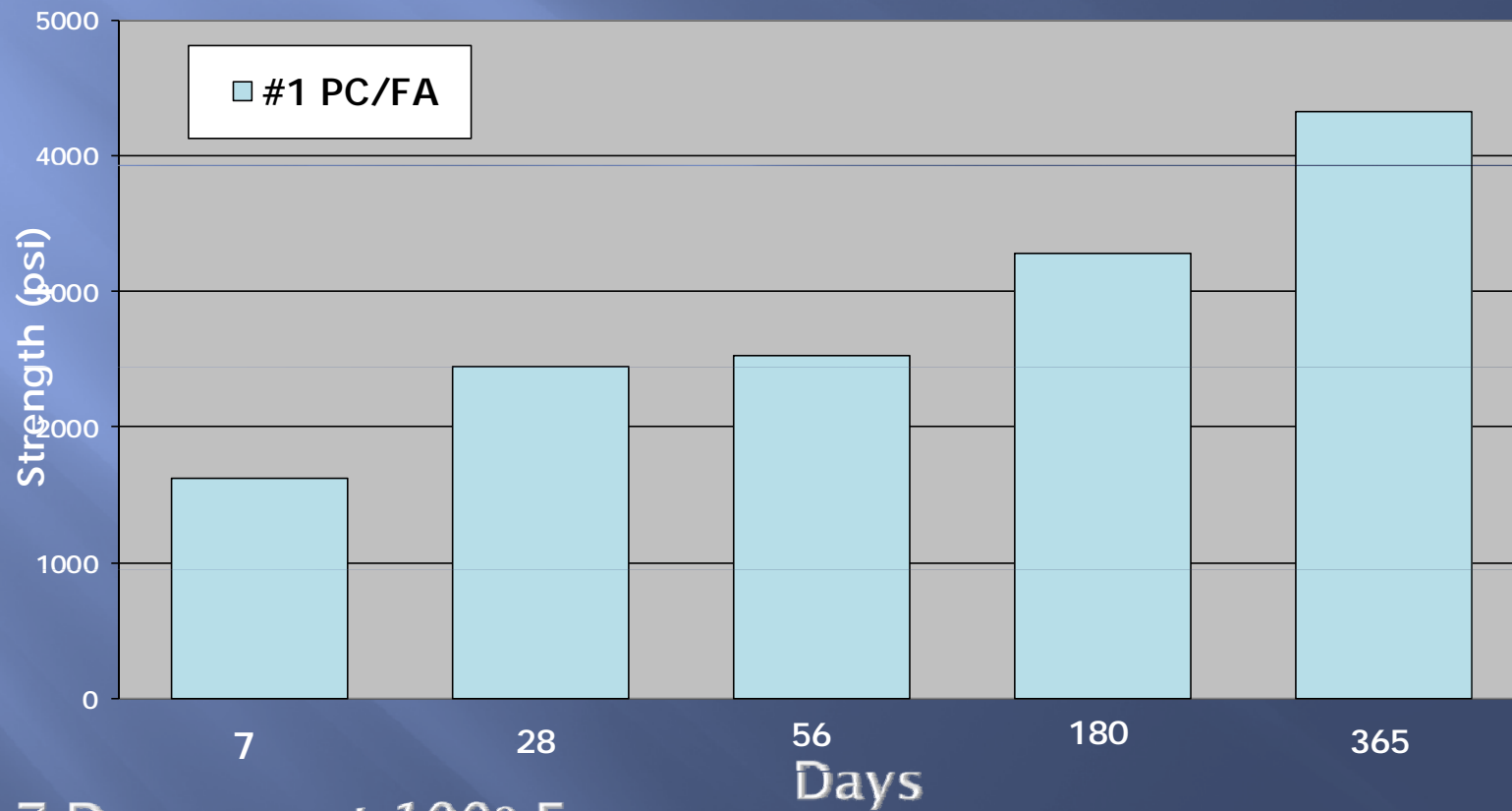


Molding Cylinders  
for Compressive Strength  
(Standard Proctor Equipment)



# EcoPad Compressive Strength

(Field Molded Samples, Air Dried)



7 Day cure at 100° F

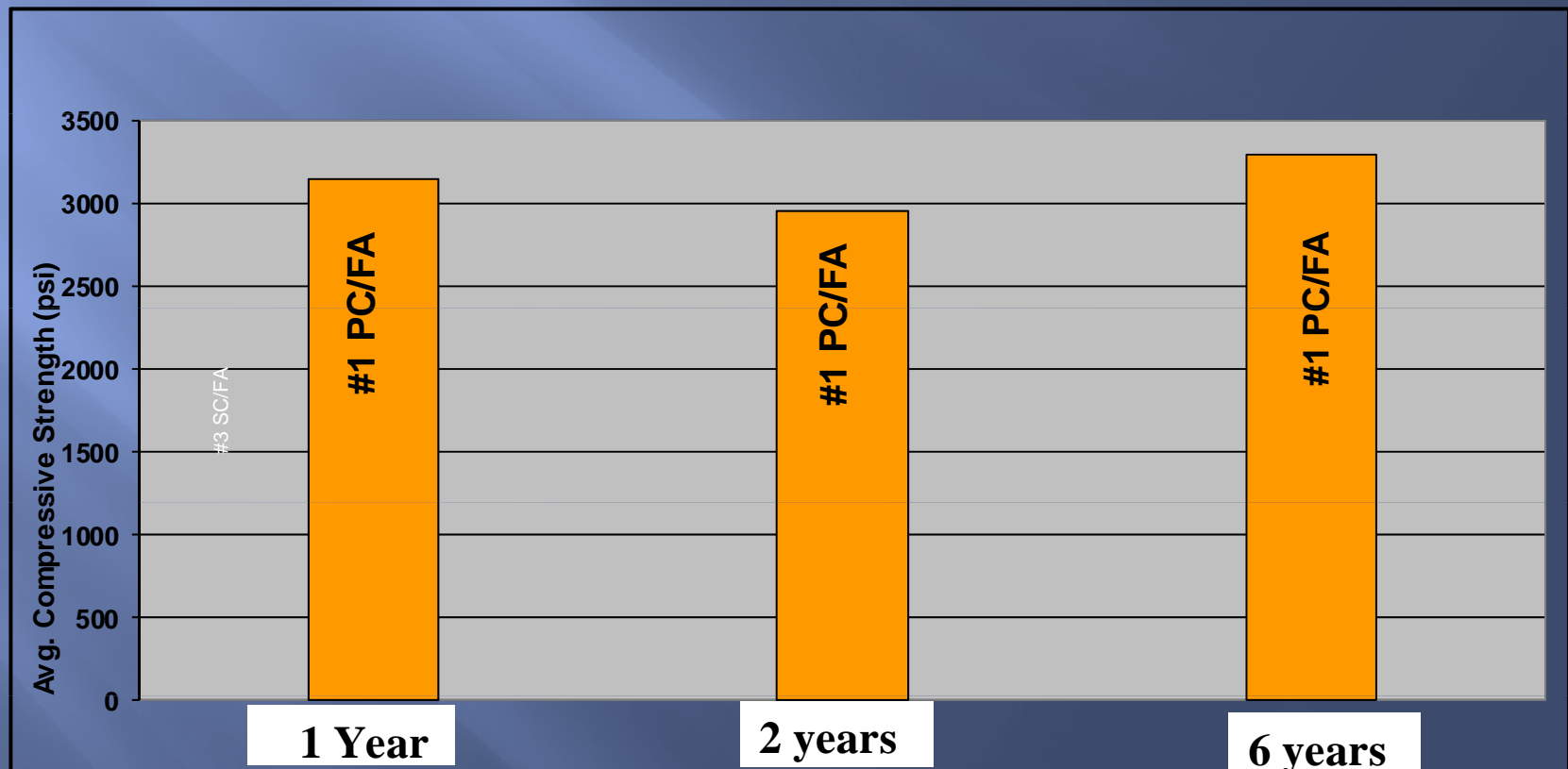


# Core Sampling at 1 Year





# P4 EcoPad Compressive Strength (Core Samples, Air Dried)



# P4 EcoPad After 1 Year of Service





# Benefits of In-Situ Mixed Concrete EcoPad

Reduced Construction Costs

Expedited Schedule

Impervious, Durable Surface

Resource Conservation

Co-Utilize Byproducts / Recycling:

- Bottom Ash

- Recycled Concrete

- (Foundry Sand, Ground Slag, etc.)

Use Local or On-Site Materials



# Applications for Concrete EcoPads:

## Working Spaces:

### Stockyards –

Durable, Weather Resistant, Cost Effective for Large Spaces

### Equipment Laydown Areas –

Heavy Bearing Capacity, Excellent Traction

## Linear Projects:

### Plant Haul Roads & Service Roads –

Fast Installation, High Capacity & Low Maintenance

### Rustic Park Roads –

Low Cost, Fast Installation and Natural Appearance  
Ecological and Sustainable “Green Advantage”

Anywhere a Low Cost, Durable Surface is Needed.





