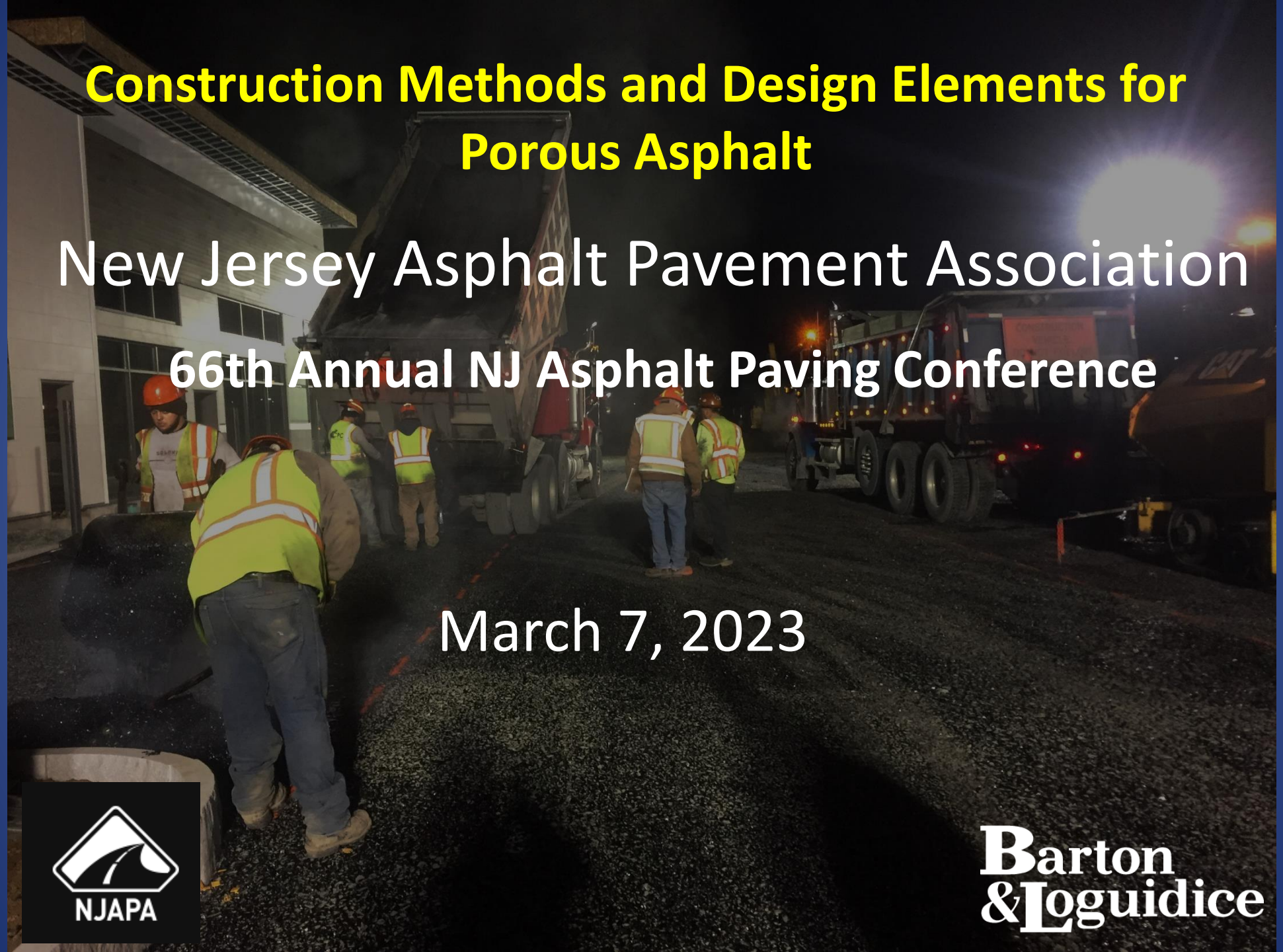
# Construction Methods and Design Elements for Porous Asphalt



## New Jersey Asphalt Pavement Association

### 66th Annual NJ Asphalt Paving Conference

March 7, 2023

NJAPA

Barton & Loguidice

# Demonstration Project - Lake George, NY

## NYSDEC Impaired Waterbody (303d)

## Chlorides, Road Pollutants, Silt, Urban Runoff

# Targeted Pollutants and Their Sources

**Automobile By-Products**
**Chlorides - Salt**

**Sediment**

# Roadway and Parking Areas Previously Drained Directly to the Lake

NYSDEC = 10.2 Acres Total Area

Before:

Impervious = 8.7 Acres

Pervious = 1.5 Acres

After:

Impervious = 5.6 Acres

Pervious = 4.6 Acres

Change from 15% to 45% Pervious

# Roadway and Parking Areas Previously Drained Directly to the Lake

Beach Road = 4.0 Acres Total Area

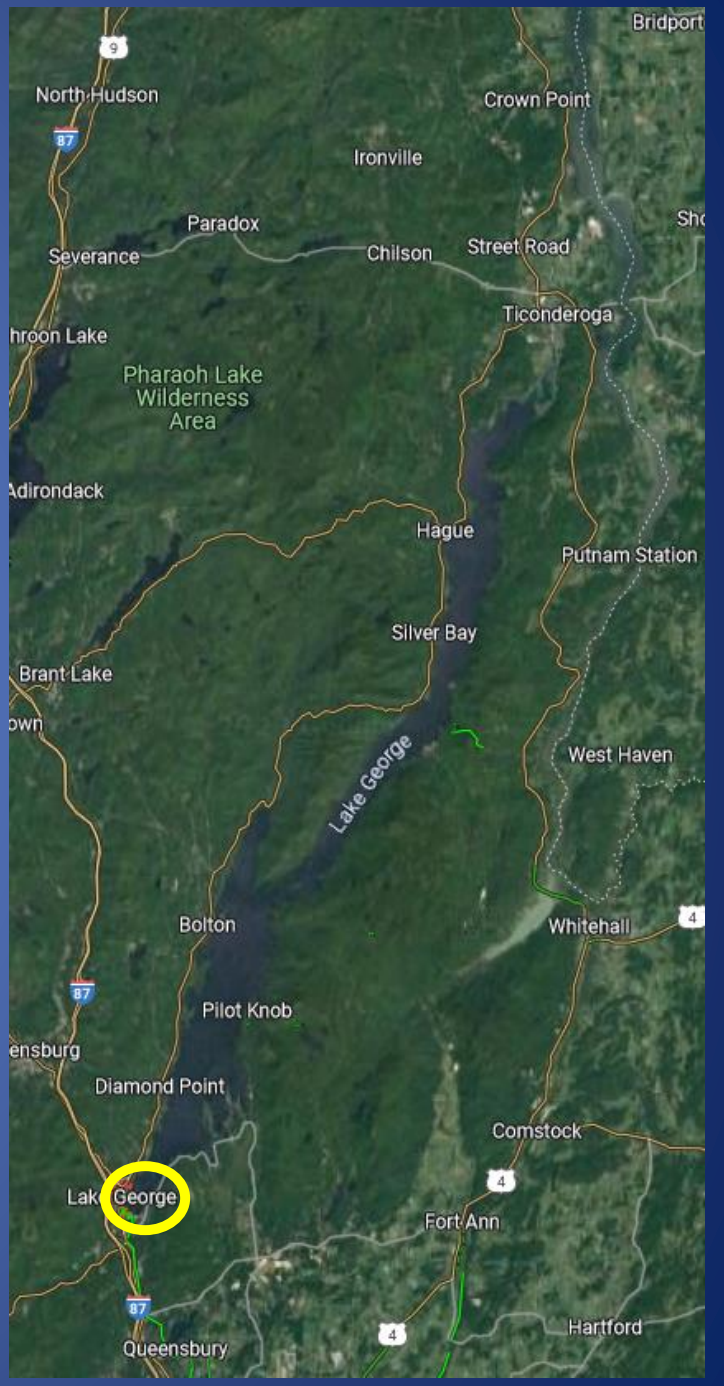
**Before:**
Impervious = 3.9 Acres
Pervious = 0.1 Acres

**After:**
Impervious = 1.2 Acres
Pervious = 2.8 acres

**Change from 3% to 70 % Pervious**

# Lake George


- Local Drinking Water Source
- Economy Dependent on Seasonal Tourism
- Real Estate at a Premium
- Construction Only September 15 to May 30

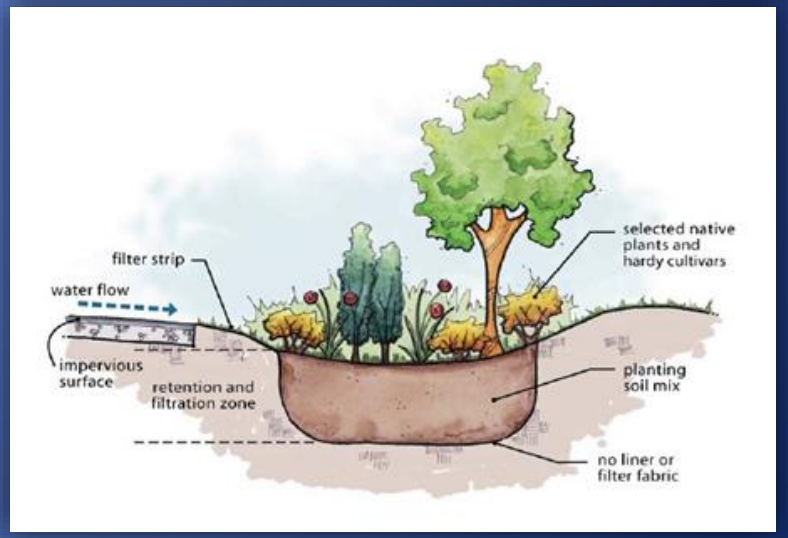



# Green Methods
# Vegetated Swales

- Used for Pre-Treatment
- Helps Preserve Primary System
- Turf Lined or Planted

# Other Green Methods - Rain Gardens


- Provides Filtration
- Transpiration
- Evaporation
- Reduces Runoff Volumes
- Aesthetically Pleasing



# Other Green Methods
# Stormwater Planters / Bio-Retention

# Green Roofs

- Very Successful Applications
- Not really Applicable for Transportation Projects

# Porous Asphalt Pavement - Why ??

- Groundwater Recharge, Runoff Reduction
- Effective Pollutant Treatment for Solids, Metals, Nutrients, and Hydrocarbons
- Little to No Closed Drainage System Needed
- Safety Improvements – Glare, Road Spray
- Hydroplaning – Friction Retention When Wet
- Little to no Black Ice - Reduced de-icing Materials
- Less Susceptible to Frost – No Capillary Action
- Noise Reduction – 1 dba to 3 dba

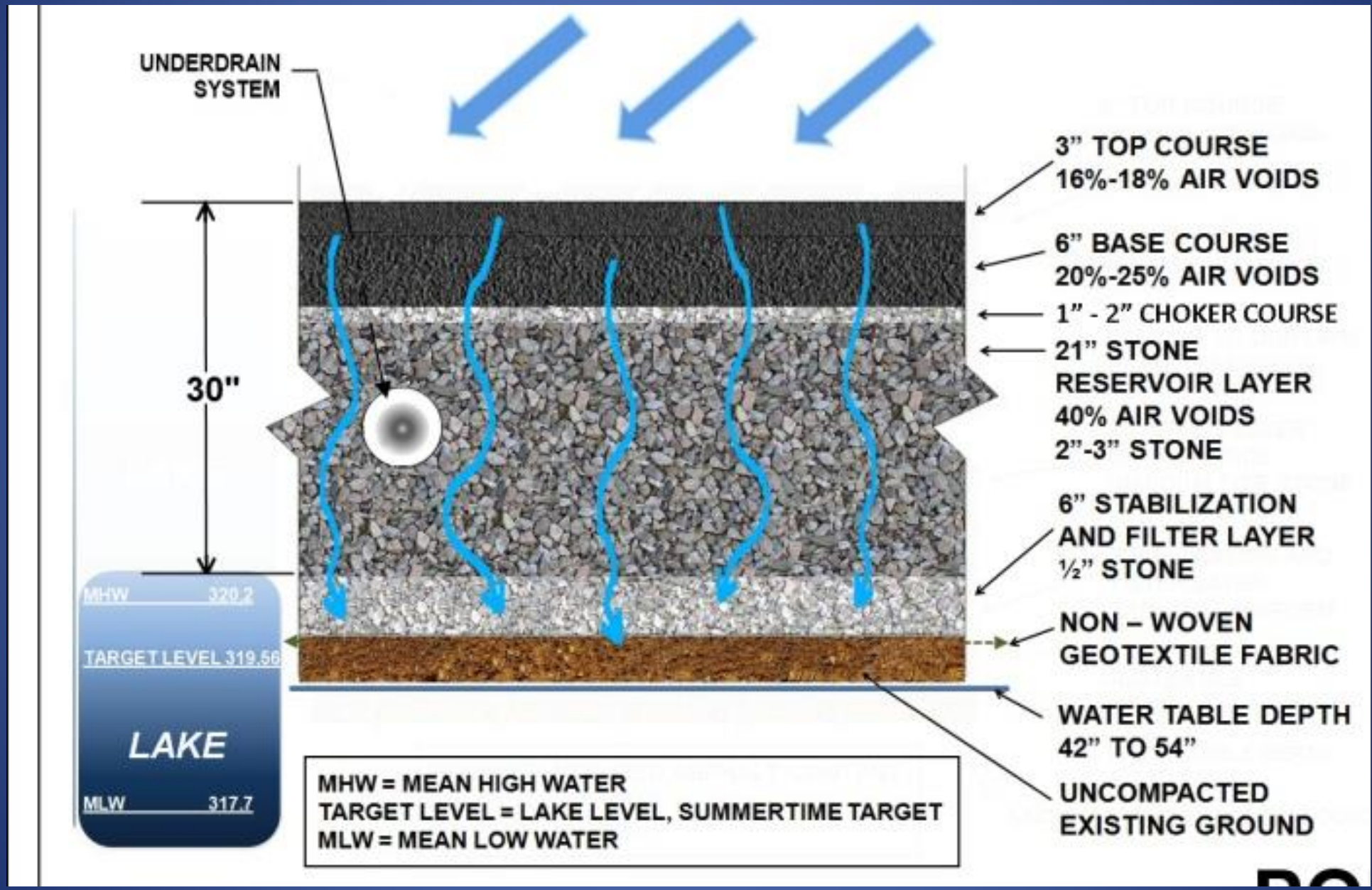
# Porous Asphalt

- Typically Parking areas, Low Volume, Low Speed Roads

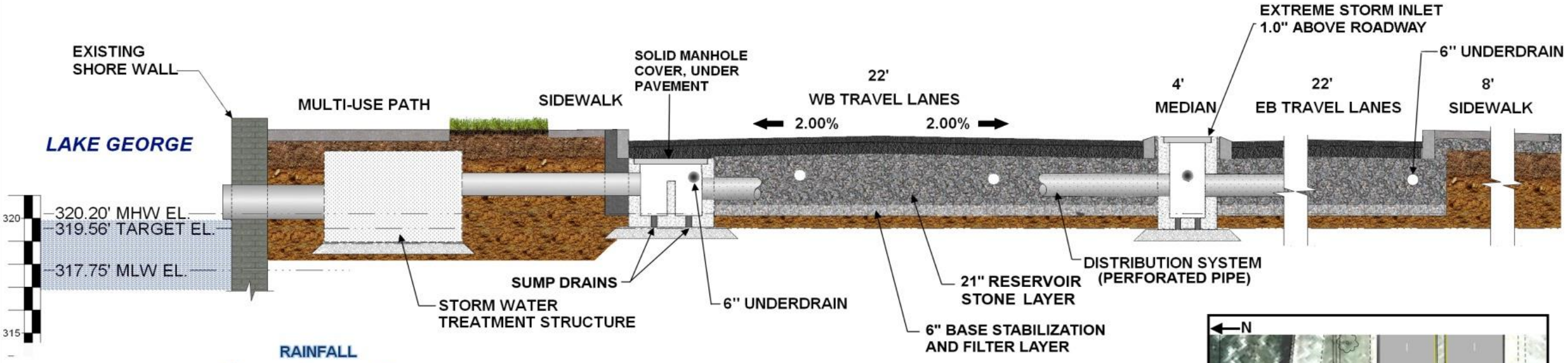
**Not used in Higher Traffic Volume, > 35 MPH or Heavy Truck Applications**

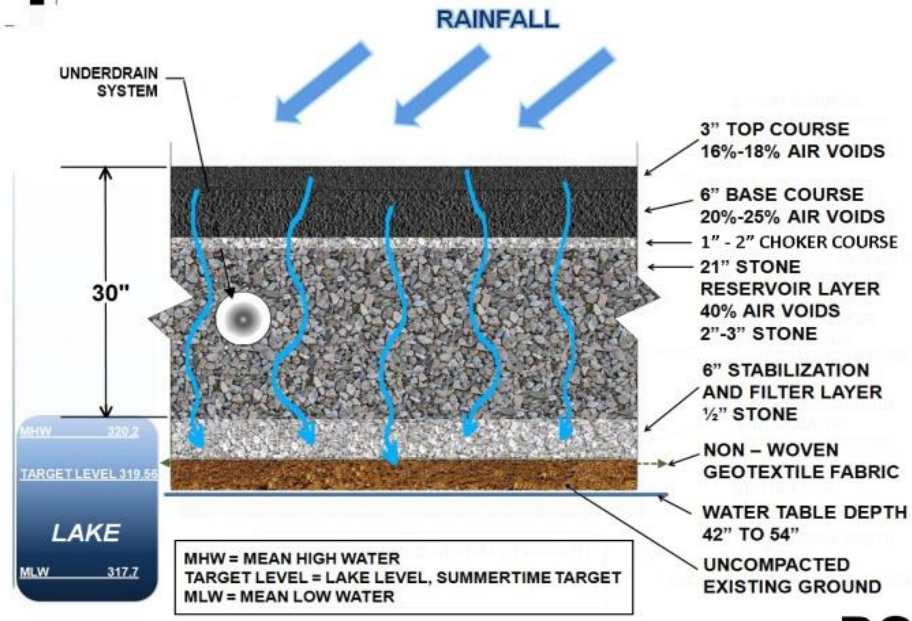
**Similar to Open Graded Asphalt Courses Permeable Base Course NYSDOT (10FX)**

# Heavy Duty Design

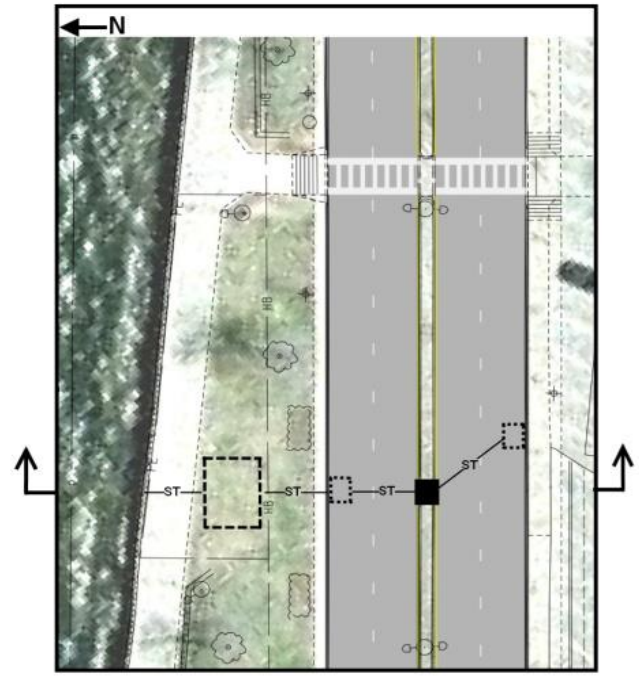


P.I.N. 1757.28




- $6 M full depth reconstruction project – 2.3 lane miles
- Section designed to store up to 6" in 24-hours
- Reduced salt de-icing – by approximately 50% (8,000 lbs)
- Designed for 10,000 vehicles per day (4% Truck Traffic)
- Requires special HMA design – Polymers, Binders, Fibers
- Polymer modified asphalt content 2%-3% top, 6% base
- Construction to begin spring 2012



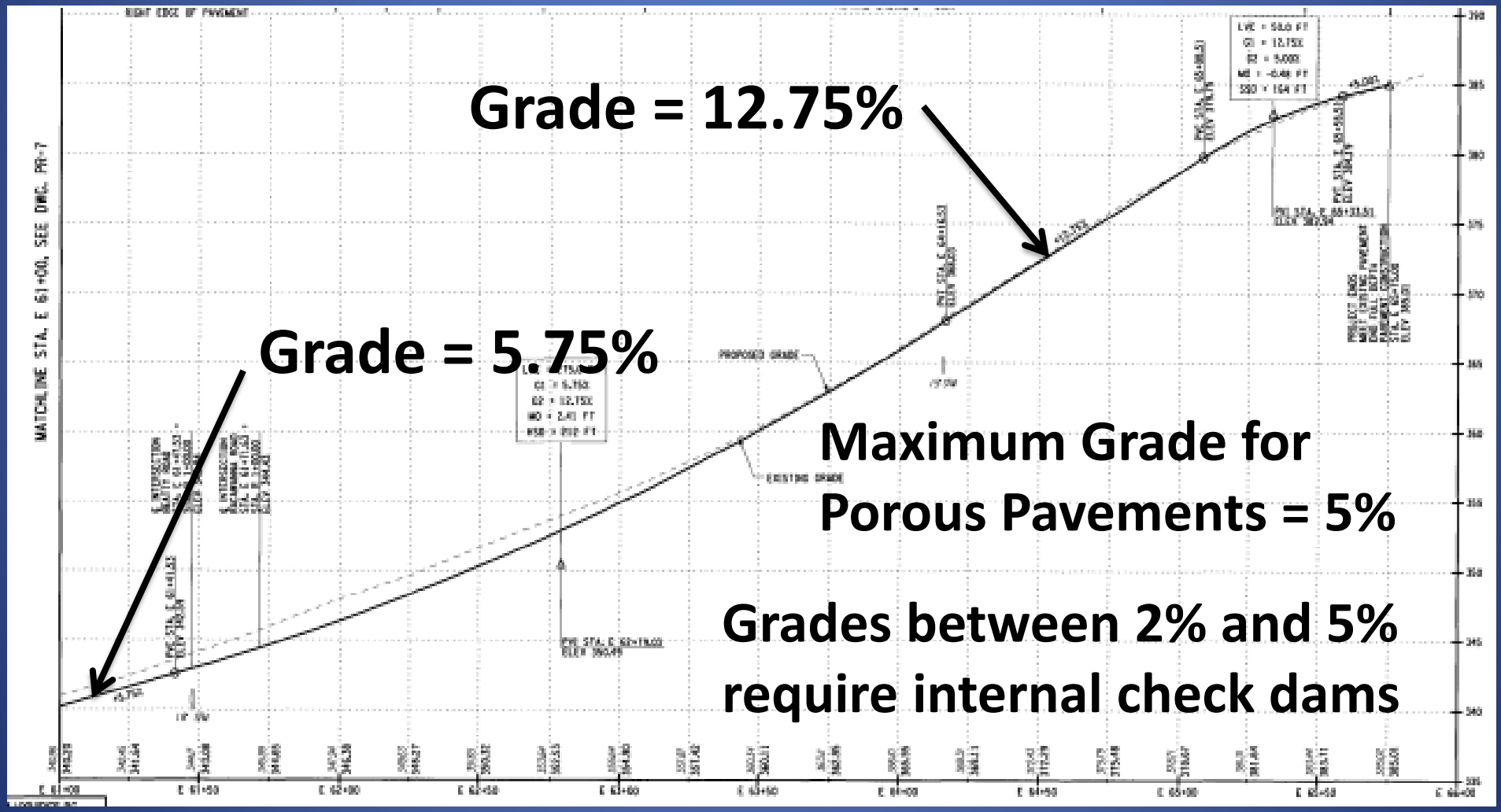

# POROUS PAVEMENT SYSTEM
# BEACH ROAD, LAKE GEORGE, WARREN COUNTY, N.Y.

# Application Cautions

## Roadway Grade

# Application Cautions

## Roadway Grade



# Application Cautions

- Not Recommended for Tight High Turnover Parking Lots
- 18’ Min Driving Lane with 9’ wide parking spaces if possible
- Angle Parking Recommended or use Wide Driving Lane 20’+
- No Medium or Heavy Trucks – Can if Only Straight Through Movements
- Not Recommended for Public Parallel Parking
- Caution use on Approaches to Traffic Signals
- Pre-Filter off-site Runoff to the Pavement
- Assess Possible Contamination and Damage Sources
- Review Stone Course to be paved on Before Construction - Rutting
- ALL Elements of the Specifications can be a Pitfall if Not Followed
- Strong Maintenance Commitment in Place

# Application Cautions

- **Not Recommended for Tight Parking Lots**
- **Use an 18’ Minimum Driving Lane**

Parking Can be Challenging for Drivers

**Poor Design Example**

- 15’ Driving Lane
- Many Maneuvers
- High Turnover Rate

# Application Cautions – Good Examples

- Use Angle Parking Whenever Feasible
- Use Wide Driving Lanes


- Wide Parking Spaces

# Application Cautions

## Public Parking Challenges

# Application Cautions

- Assess Possible Contamination and Damage Sources
- Pre-Filter off-site Runoff  to the Pavement

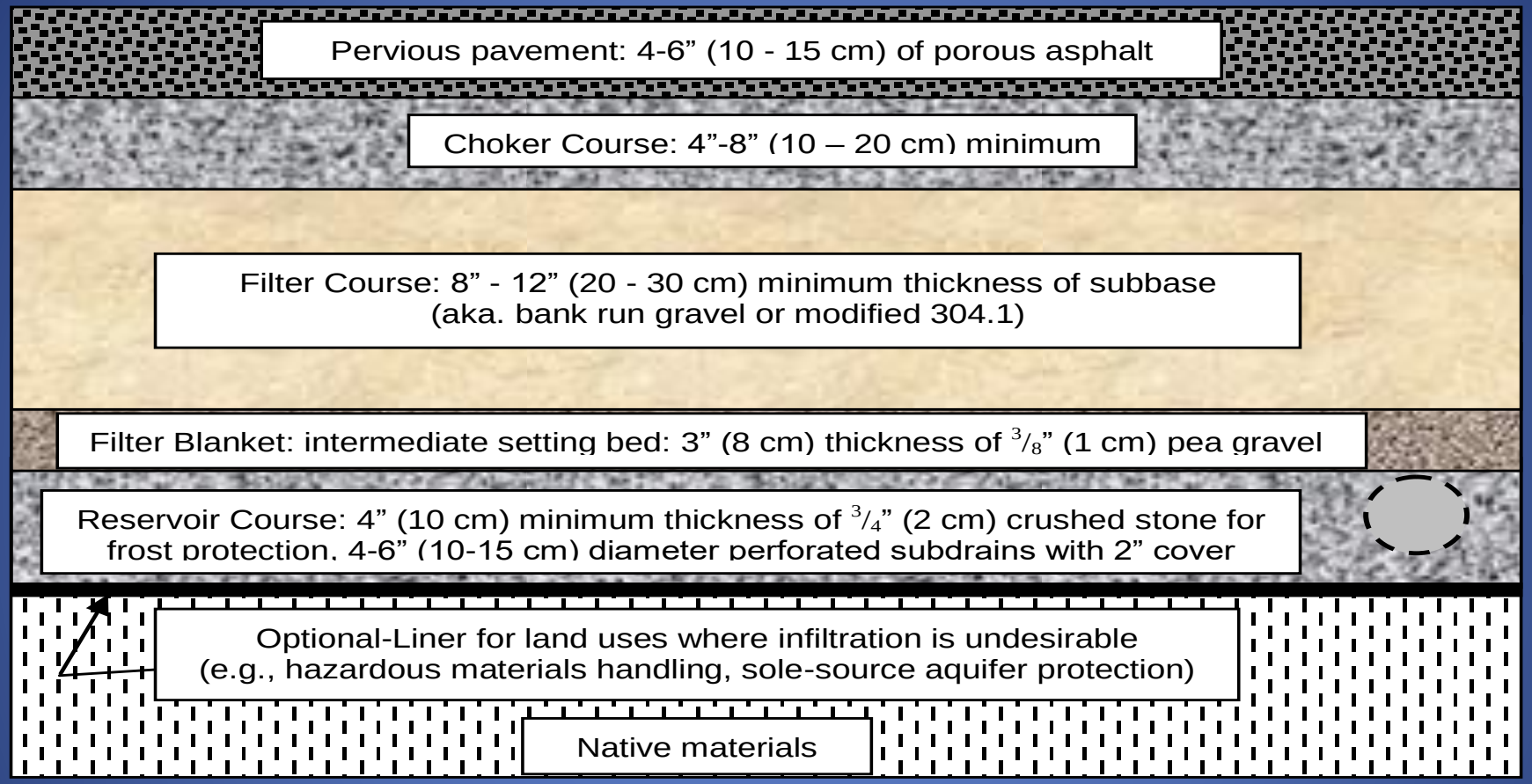
# Beach Road System Safeguards

Beach Road – August/September 2011
Hurricane Irene / Tropical Storm Lee

# Beach Road System Safeguards


Beach Road – August/September 2011
Hurricane Irene / Tropical Storm Lee

# University of New Hampshire Model

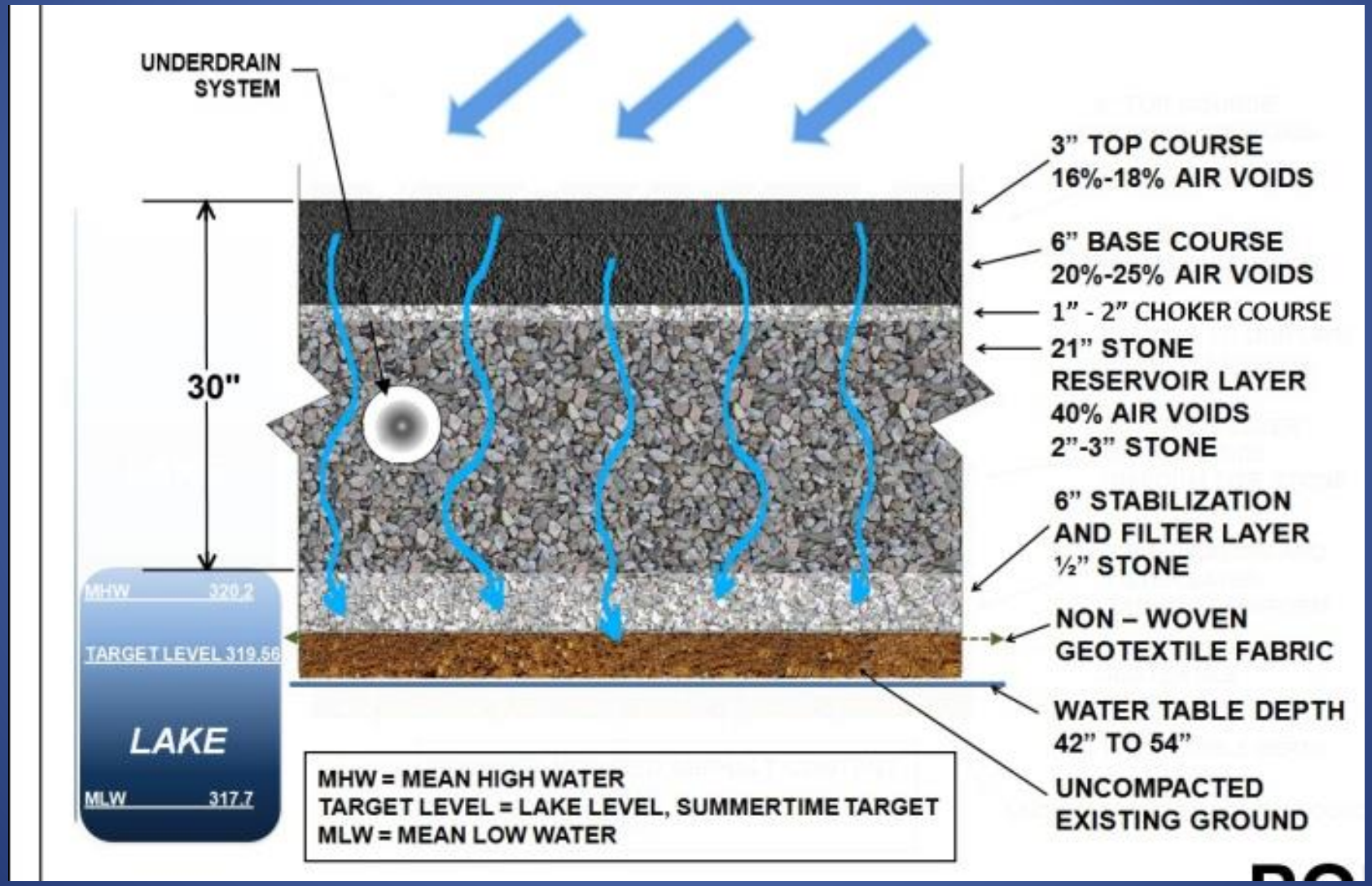



**“Layers” in NH Model Not Feasible for Beach Road in Lake George**

- **Not Essential for the project’s Targeted Pollutants**
- **Short Construction Season to install multiple layers (Winter construction only)**
- **Higher than Normal Risk for Sediment Damage in Severe Weather Conditions**
- **High Water Table Adjacent to Roadway – Lake Driven Hydrostatic Pressure**

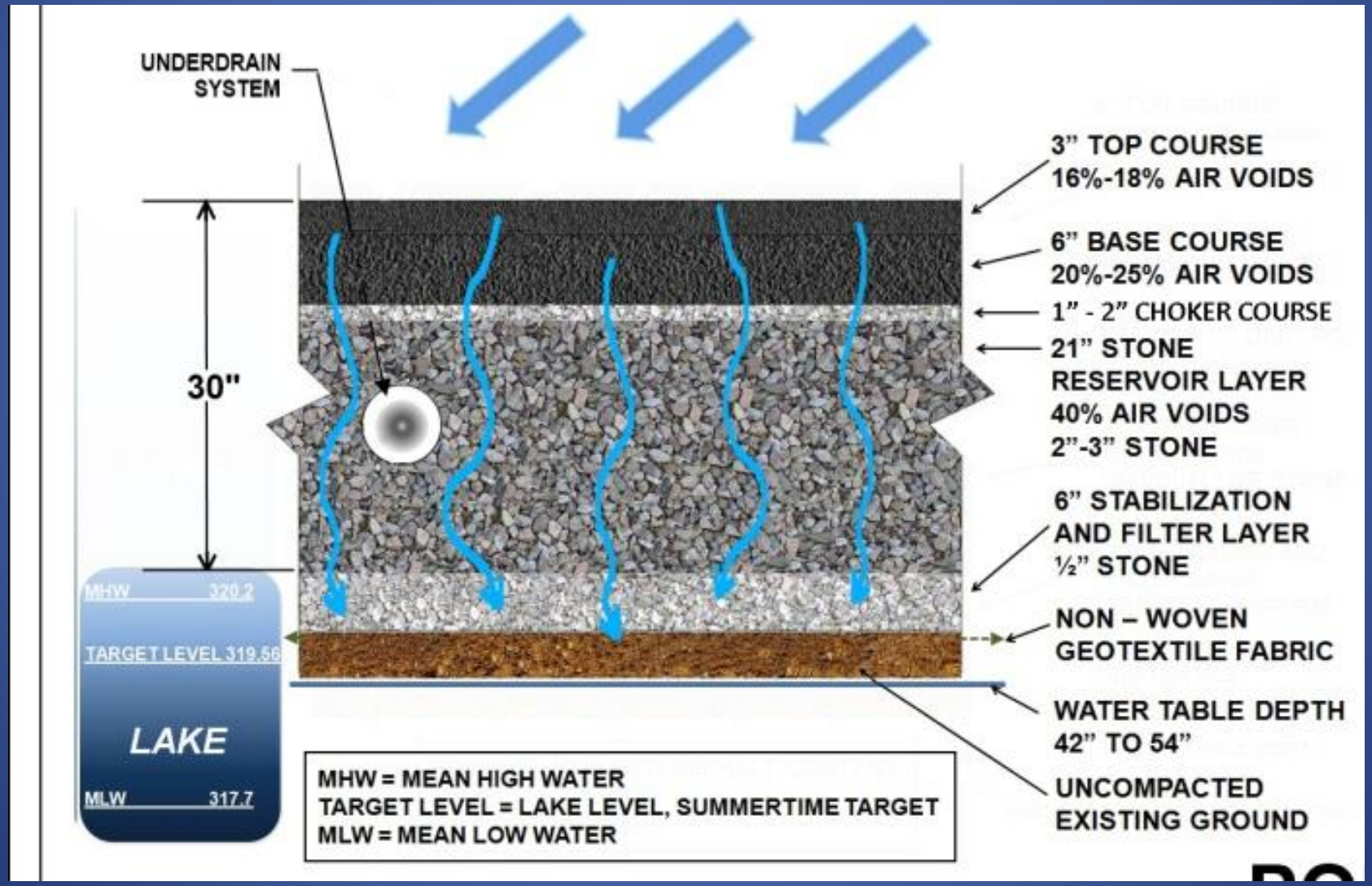
# Beach Road System Safeguards

**No Sand Layer**



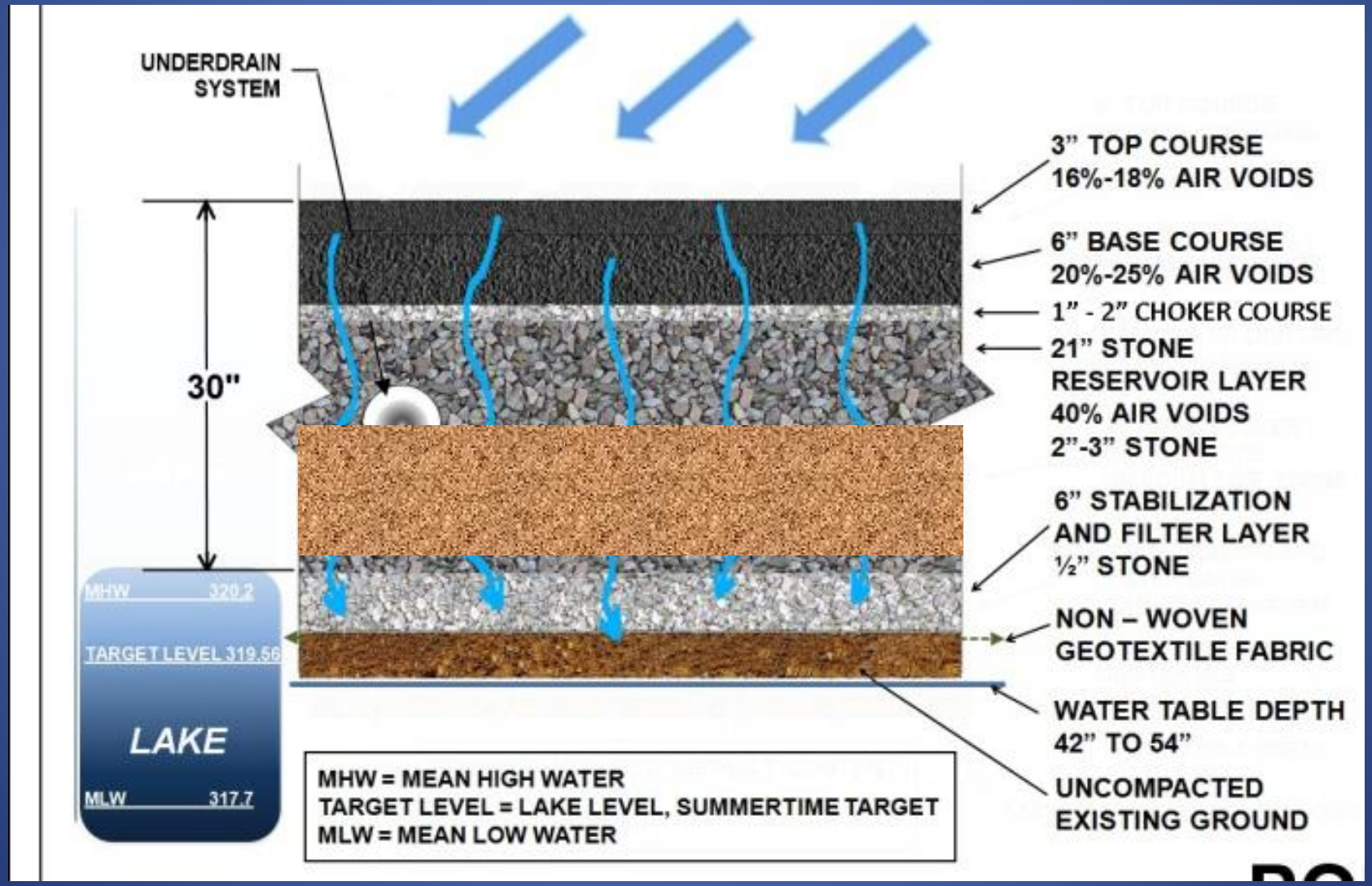
# Beach Road System Safeguards

**No Sand Layer**



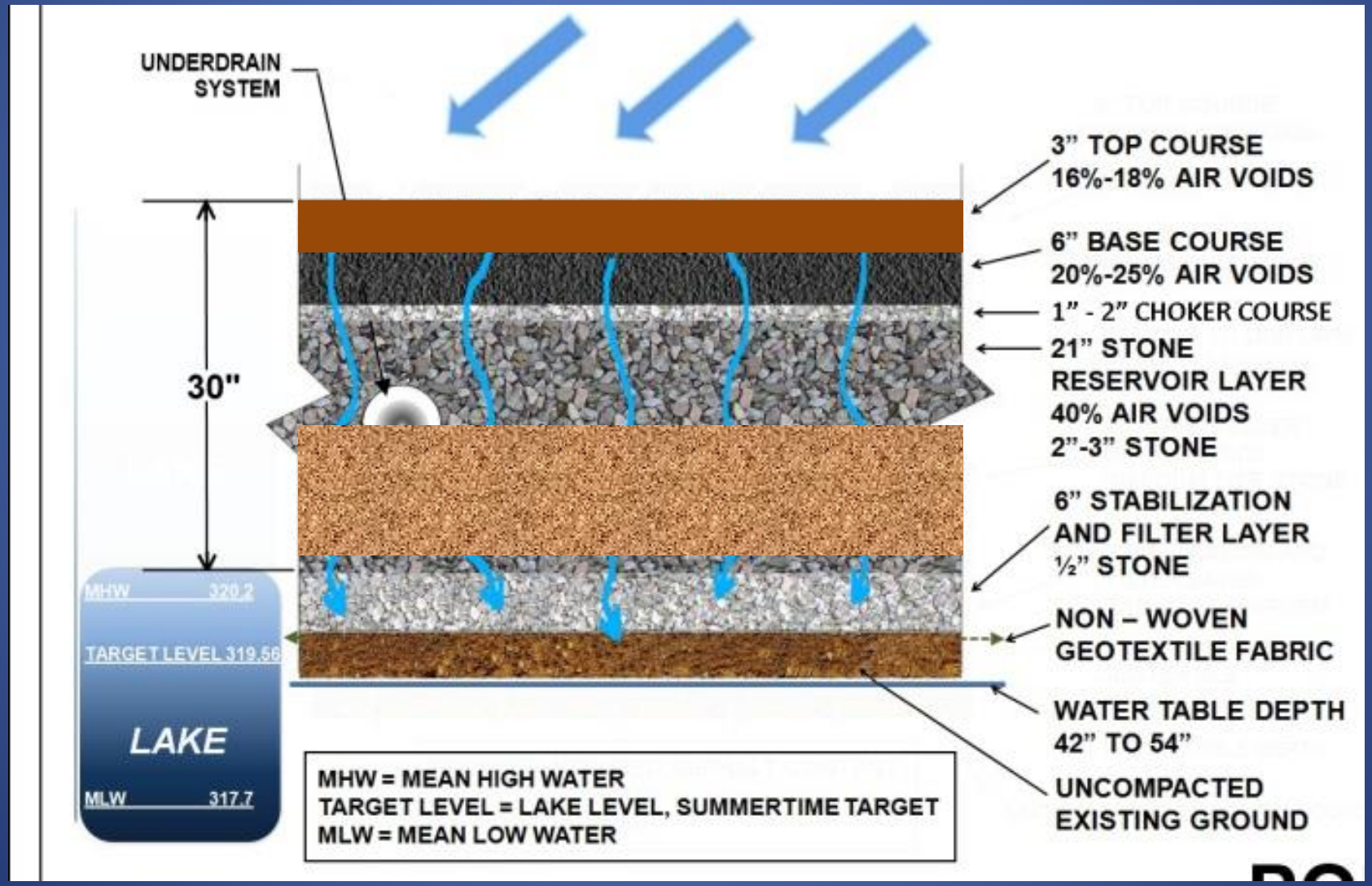
# Beach Road System Safeguards

**IF Sand Layer**



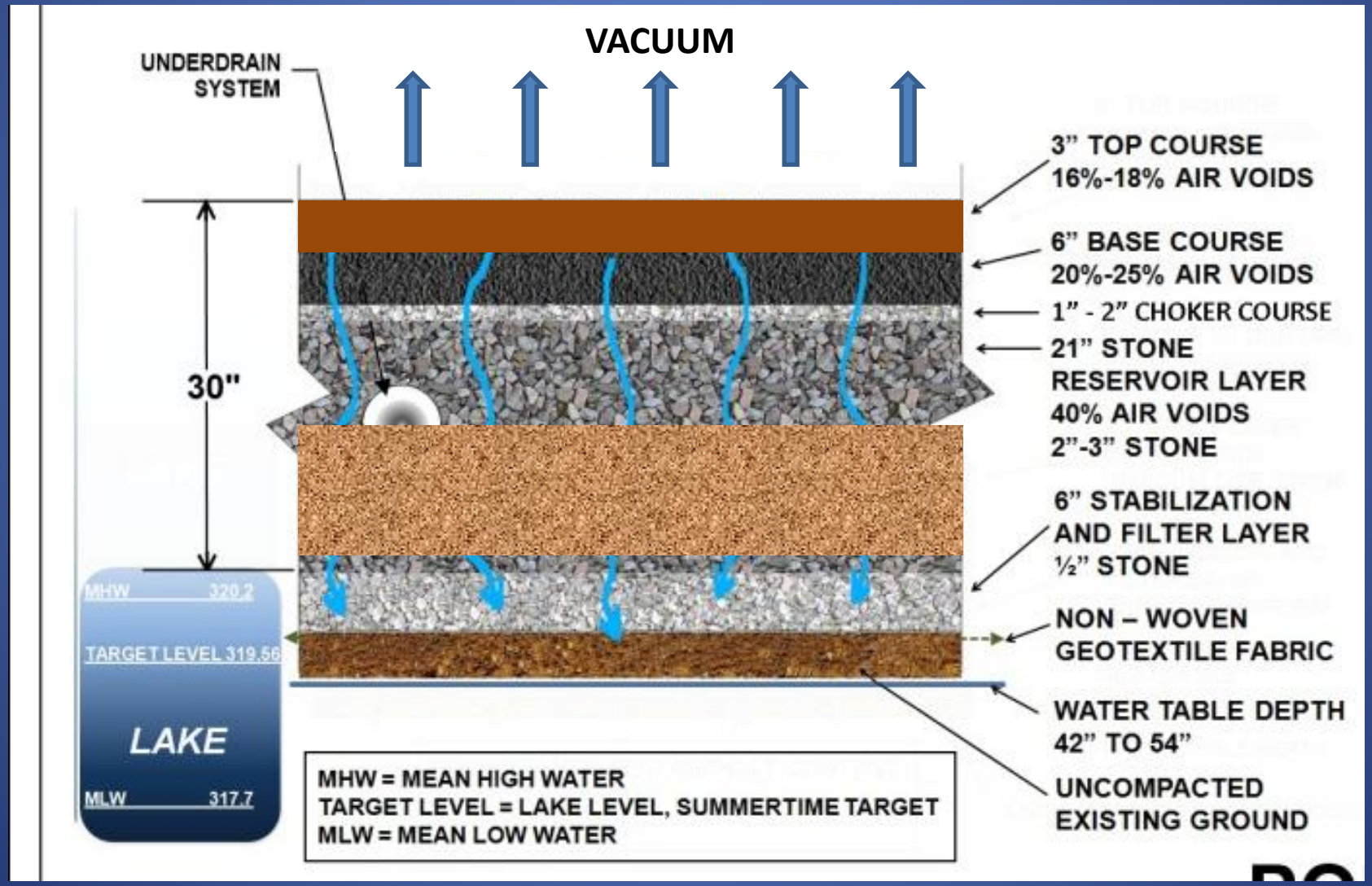
# Beach Road System Safeguards

**IF Sand Layer**



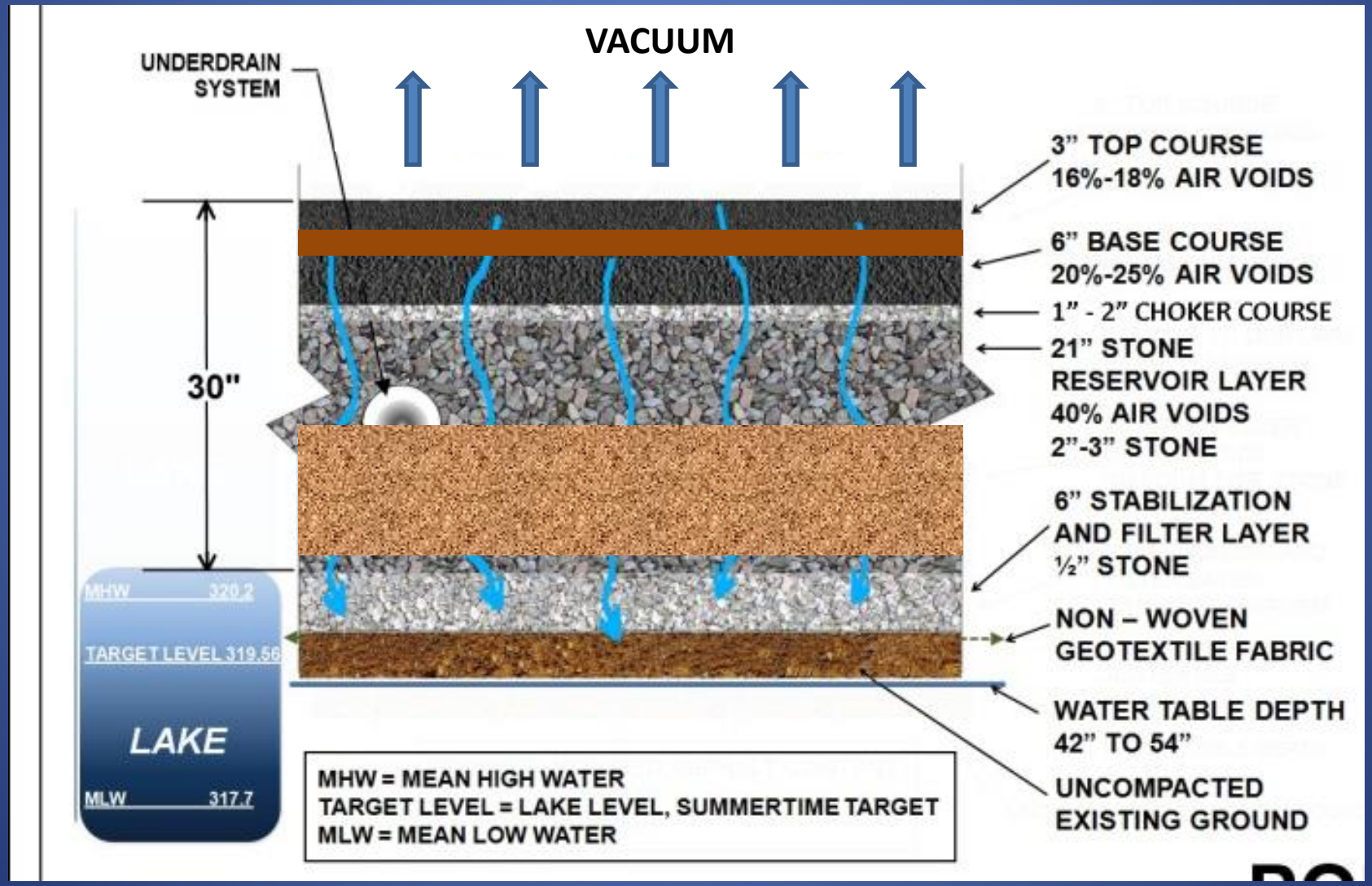
# Beach Road System Safeguards

**IF Sand Layer**



# Beach Road System Safeguards

**IF Sand Layer**



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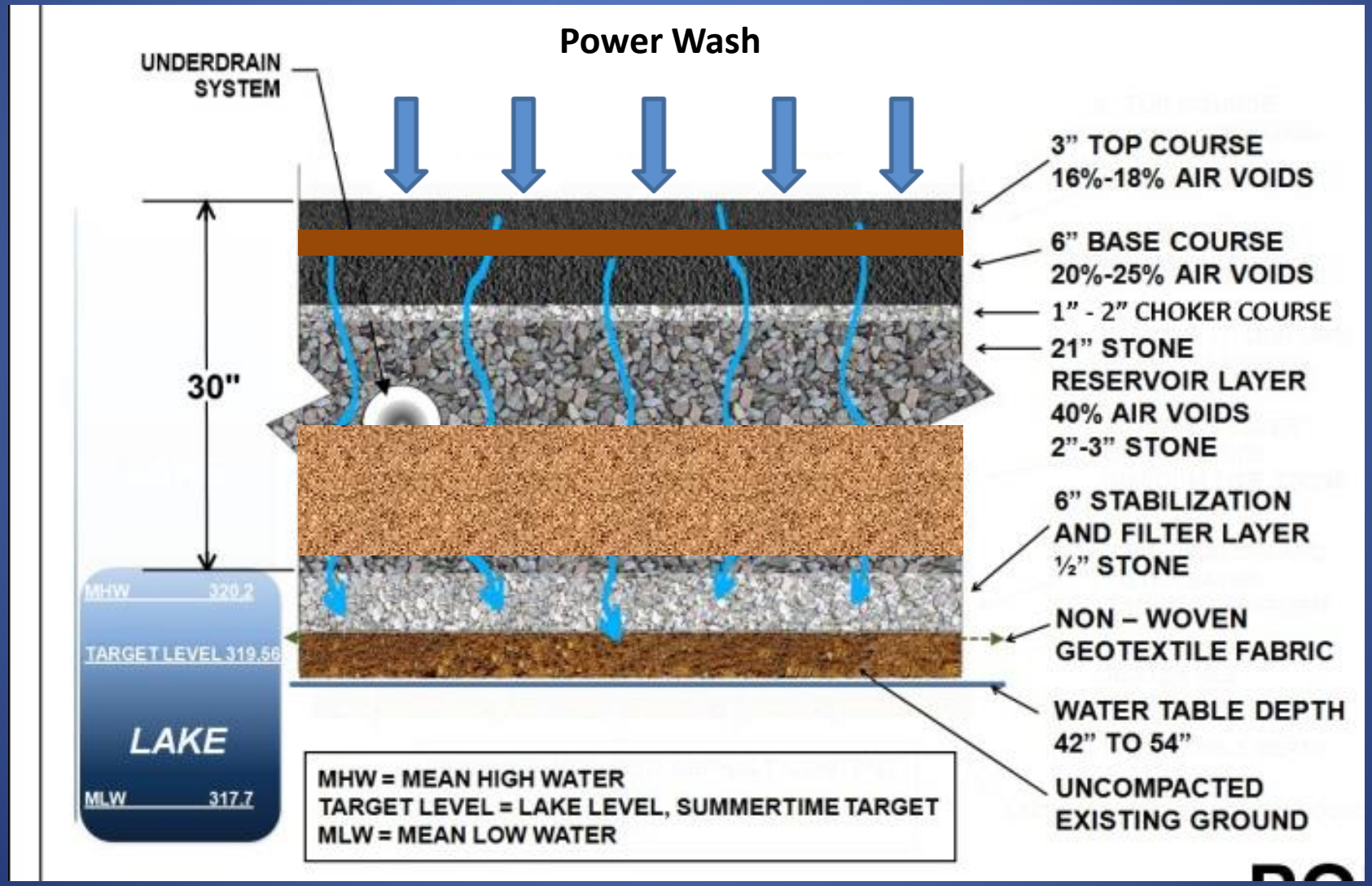
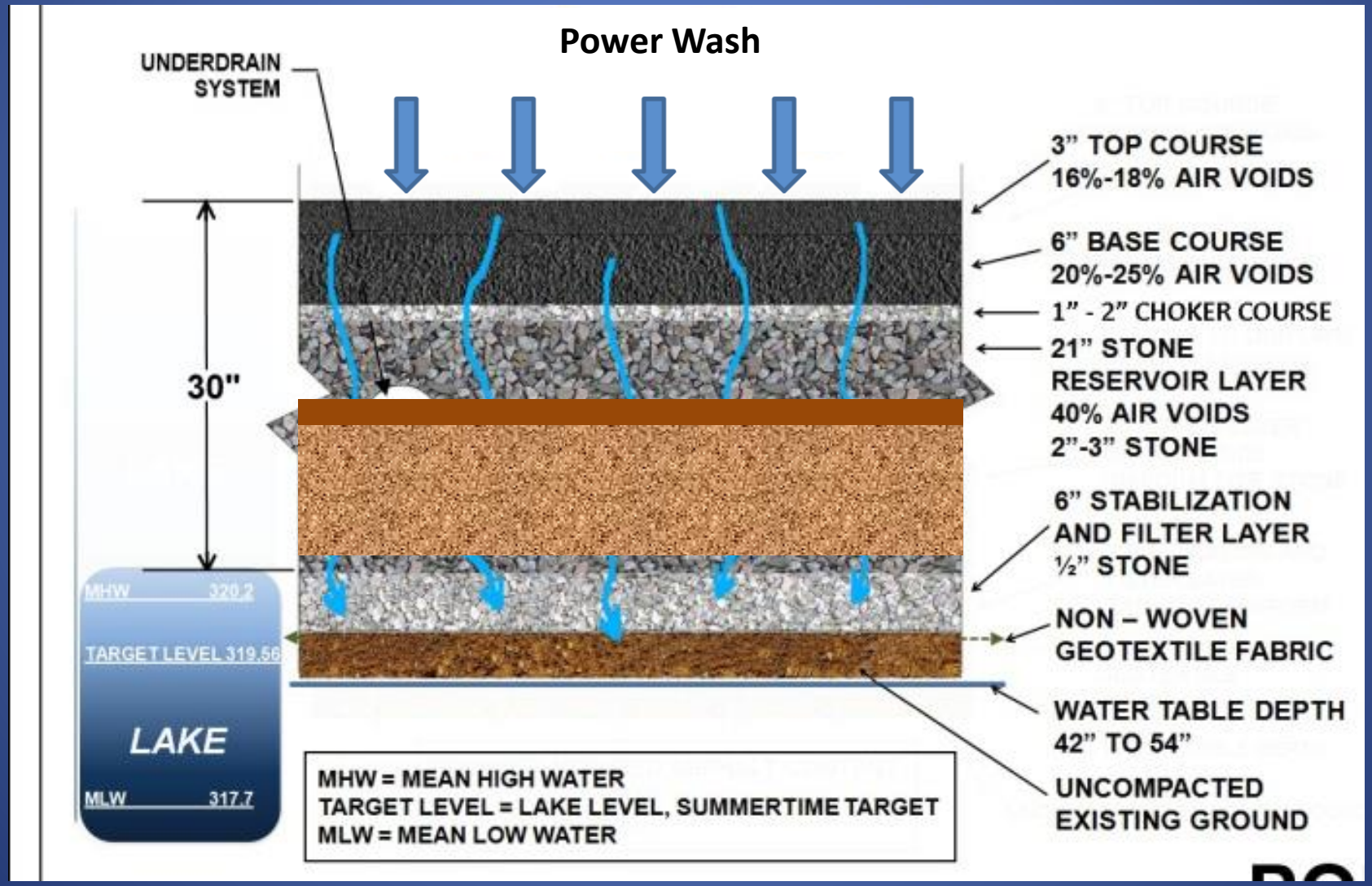
**IF Sand Layer**

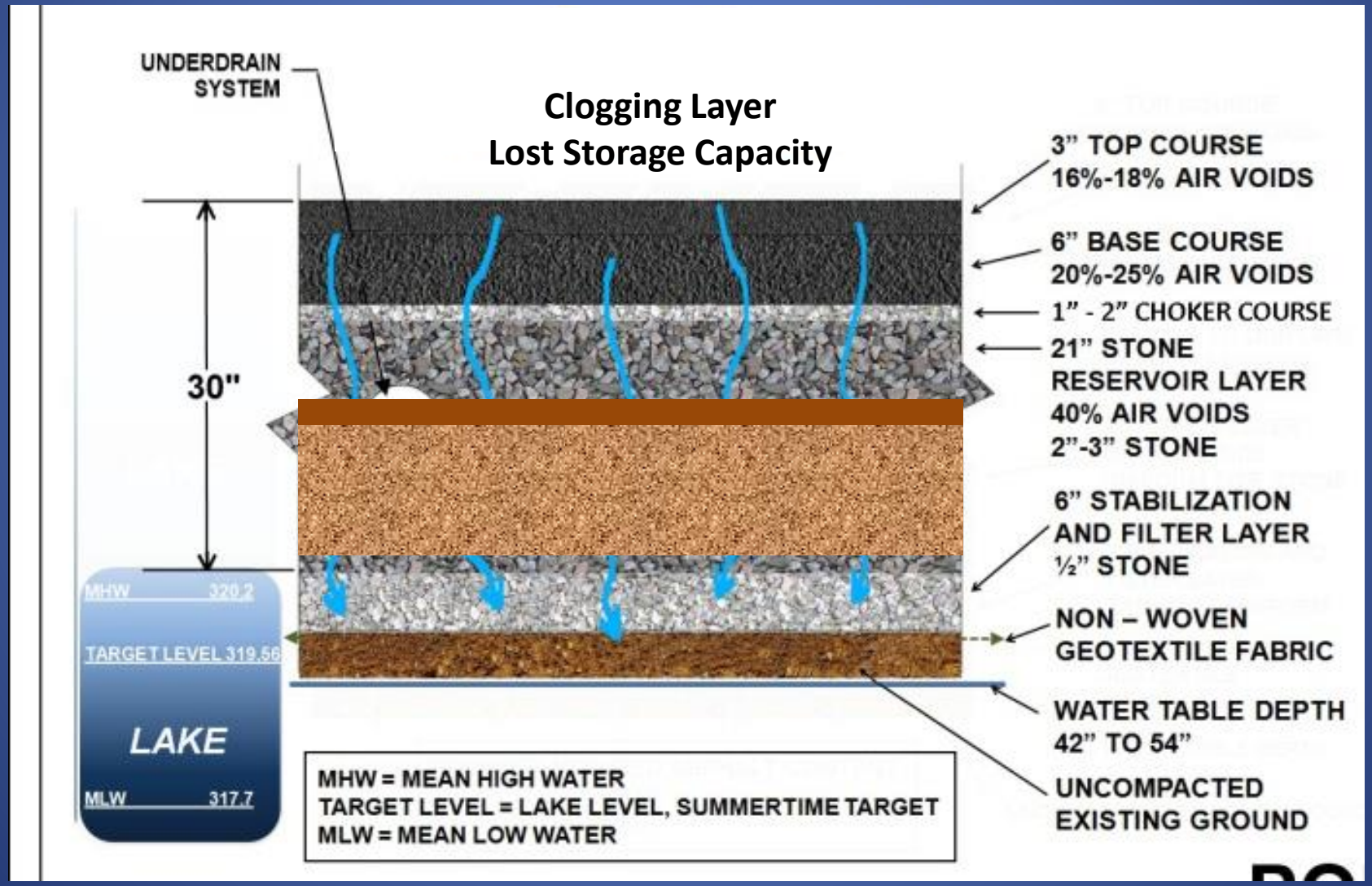


# Beach Road System Safeguards

**IF Sand Layer**

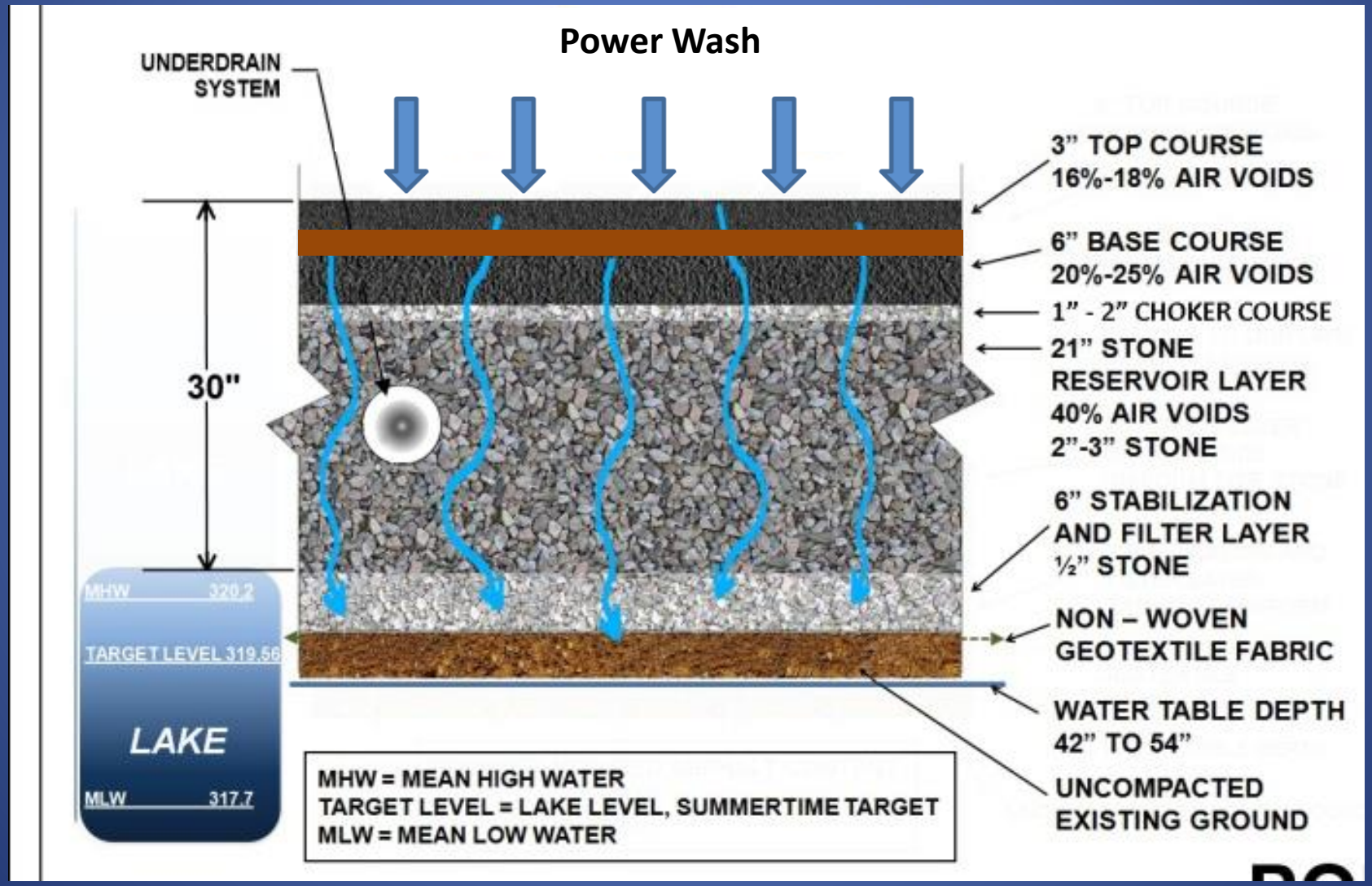


# Beach Road System Safeguards



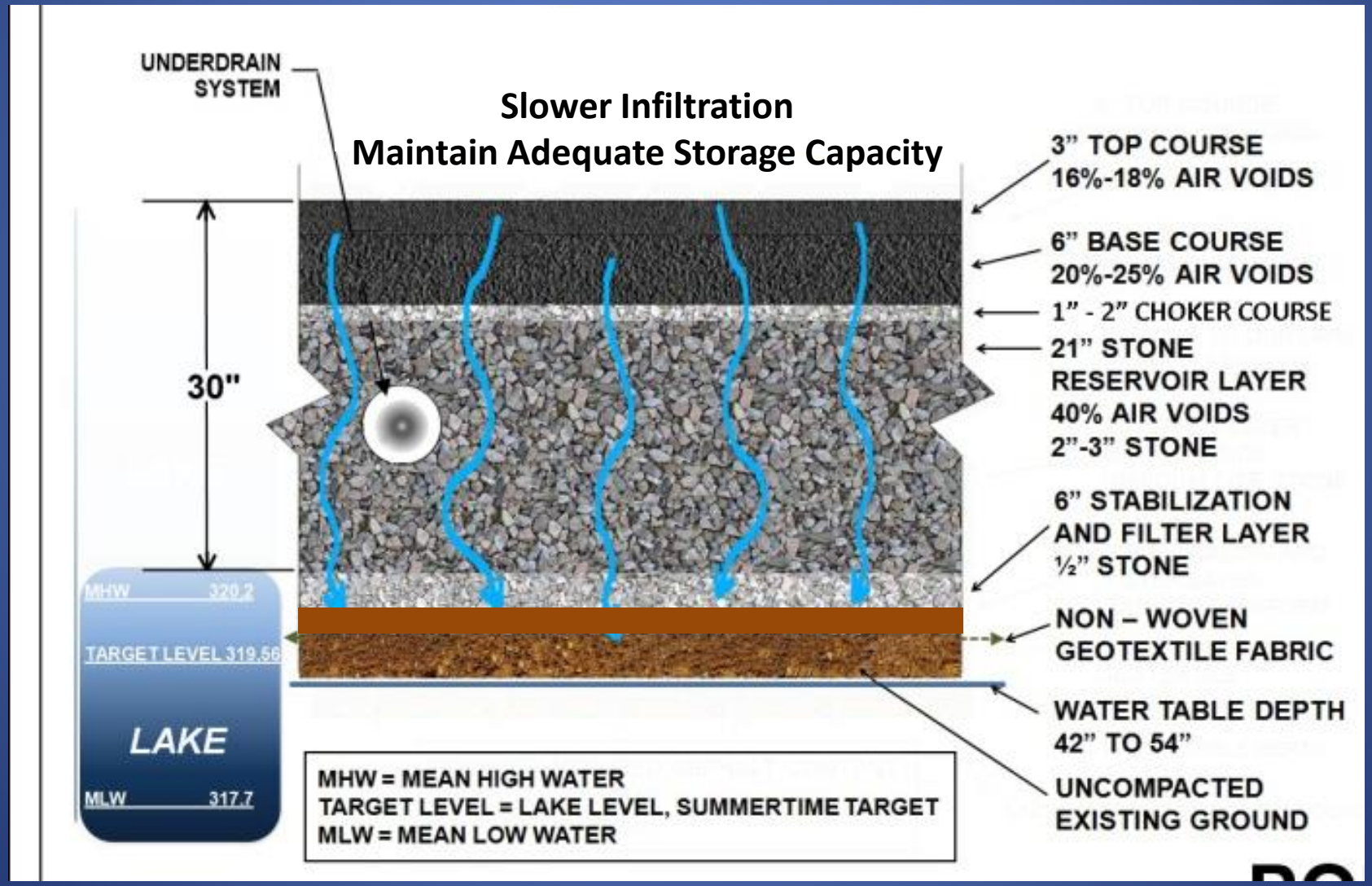
# Beach Road System Safeguards

**No Sand Layer**



# Beach Road System Safeguards

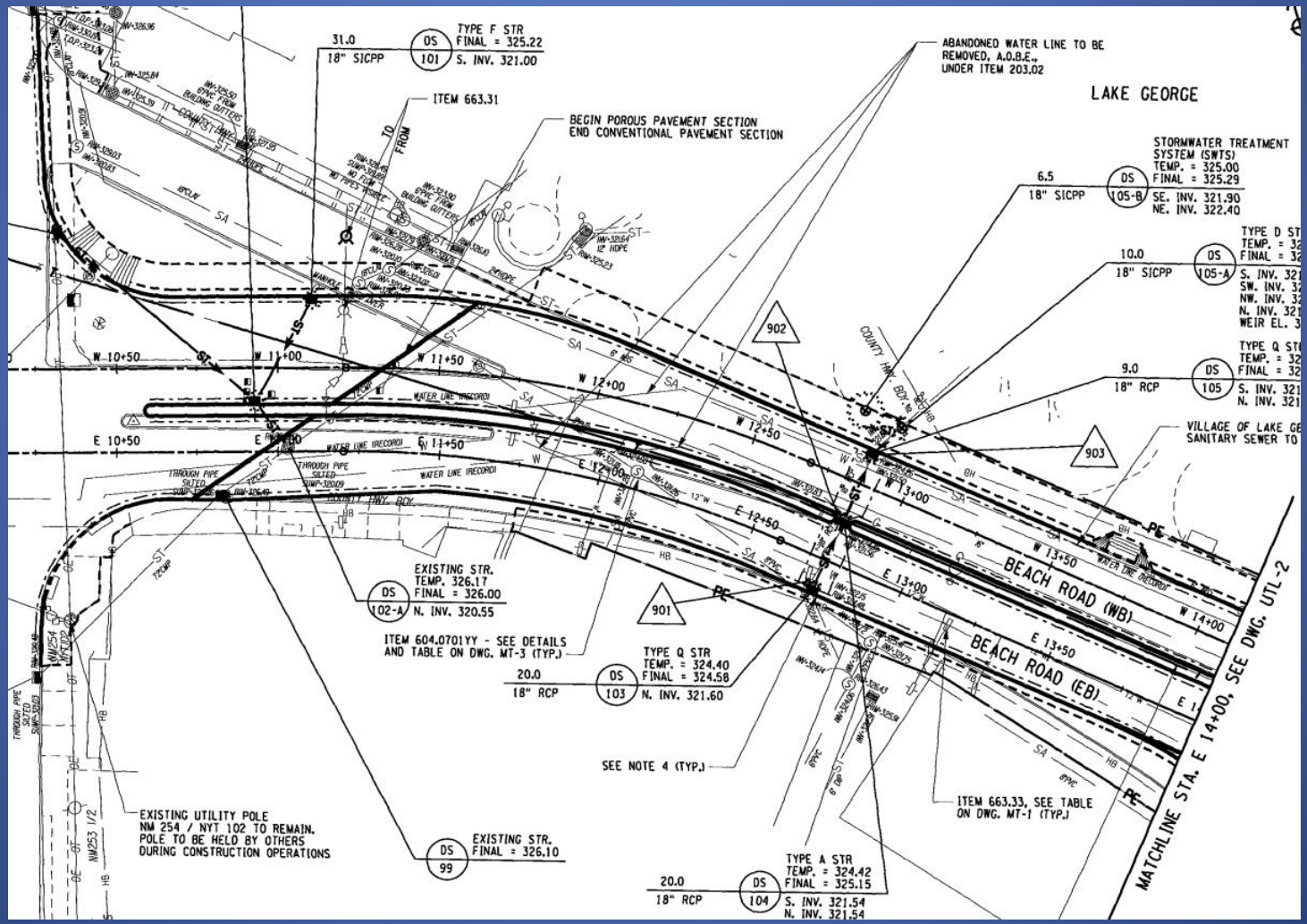
**No Sand Layer**

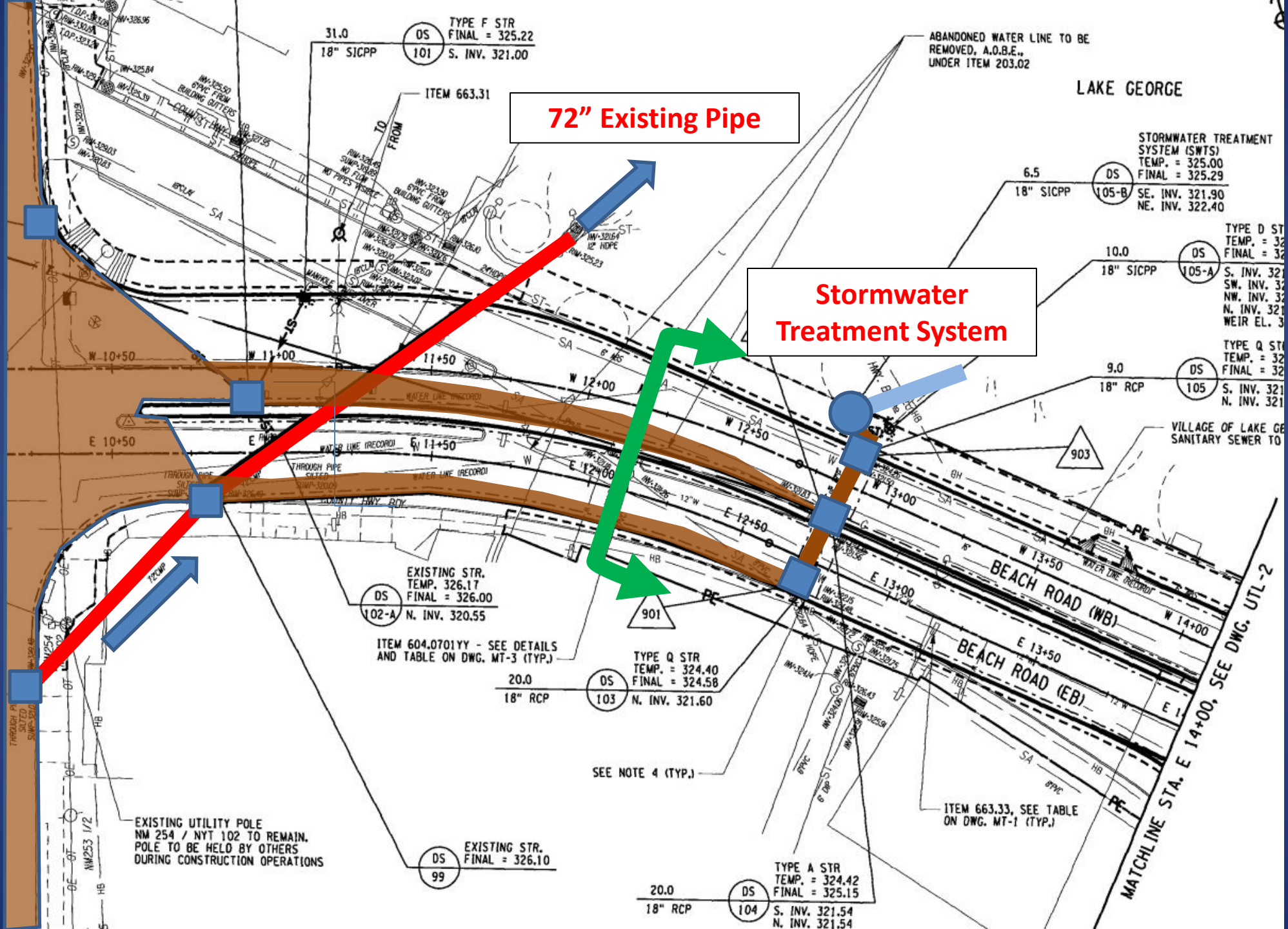


# Beach Road System Safeguards

## Offsite Contamination Protection

## Flanking Structures




72” Existing Pipe
Stormwater Treatment System
LAKE GEORGE
ABANDONED WATER LINE TO BE REMOVED, A.O.B.E., UNDER ITEM 203.02
STORMWATER TREATMENT SYSTEM (SWTS)
TEMP. = 325.00
FINAL = 325.29
SE. INV. 321.90
NE. INV. 322.40
6.5
18" SICPP
DS 105-B
31.0
18" SICPP
DS 101
TYPE F STR
FINAL = 325.22
S. INV. 321.00
ITEM 663.31
10.0
18" SICPP
DS 105-A
9.0
18" RCP
DS 105
TYPE Q STR
TEMP. = 324.40
FINAL = 324.58
N. INV. 321.60
20.0
18" RCP
DS 103
EXISTING STR.
TEMP. 326.17
FINAL = 326.00
N. INV. 320.55
DS 102-A
ITEM 604.0701YY - SEE DETAILS AND TABLE ON DWG. MT-3 (TYP.)
SEE NOTE 4 (TYP.)
EXISTING UTILITY POLE
NM 254 / NYT 102 TO REMAIN.
POLE TO BE HELD BY OTHERS
DURING CONSTRUCTION OPERATIONS
EXISTING STR.
FINAL = 326.10
DS 99
TYPE A STR
TEMP. = 324.42
FINAL = 325.15
S. INV. 321.54
N. INV. 321.54
20.0
18" RCP
DS 104
ITEM 663.33, SEE TABLE ON DWG. MT-1 (TYP.)
BEACH ROAD (WB)
BEACH ROAD (EB)
VILLAGE OF LAKE GE
SANITARY SEWER TO
MATCHLINE STA. E 14+00, SEE DWG. UTL-2
901
903
W 10+50
W 11+00
W 11+50
W 12+00
W 12+50
W 13+00
W 13+50
W 14+00
E 10+50
E 11+50
E 12+00
E 12+50
E 13+00
E 13+50


What Contamination is Possible ?
HAMM
• Tree Leaves
• Stormwater Runoff from Woods

# Application Cautions

- **Review Stone Courses to be Paved on - Rutting**

# Stone Courses

# Stone Courses

# Stone Courses

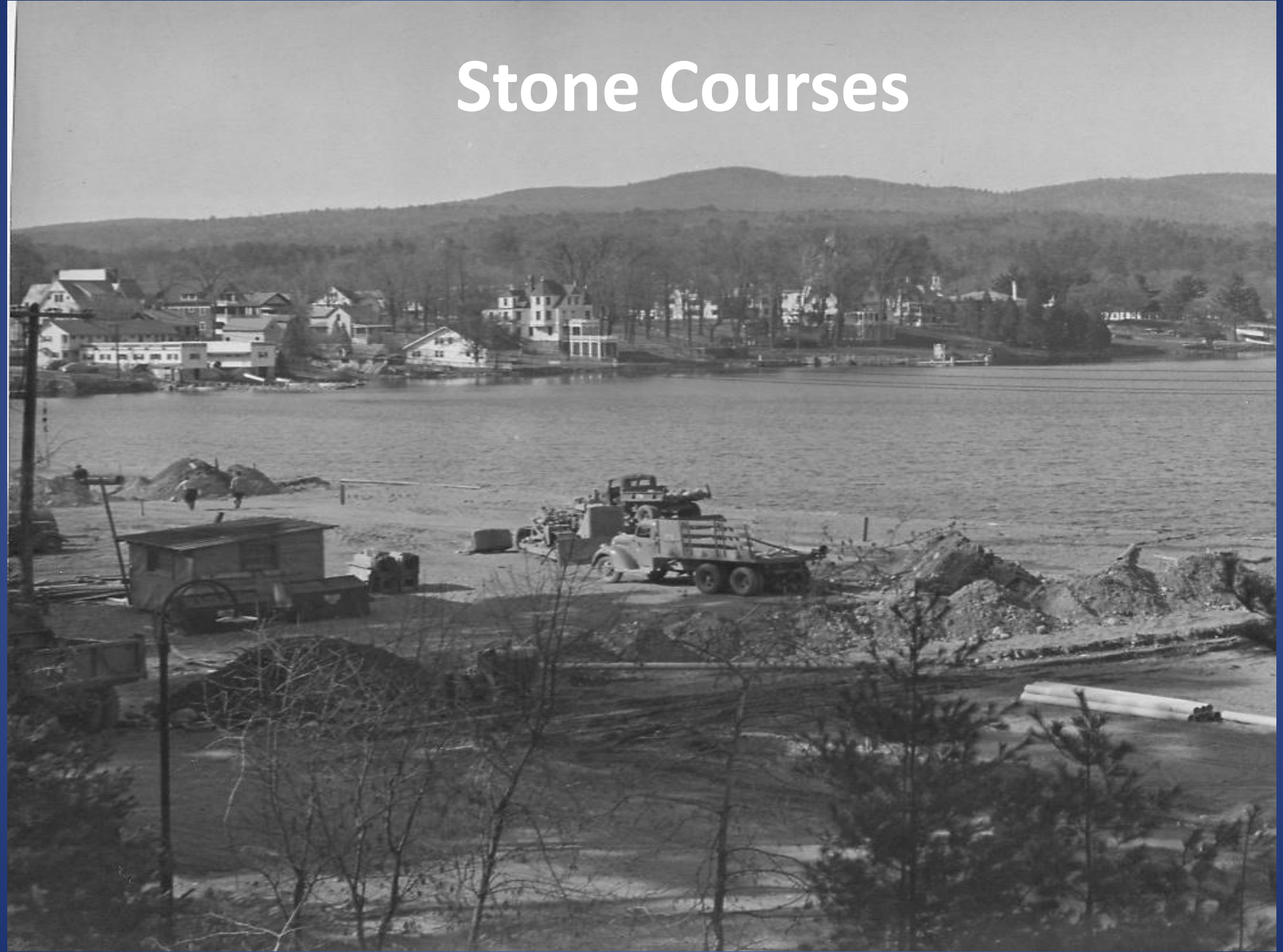
**Choker Course**

**100% Fractured**
**NYSDOT #2's**
**(+/- AASHTO #57)**
**WASHED**

# Stone Courses

¾” Choker Course
Compacted into
NYSDOT 4A’s
All WASHED

# Stone Courses



# Stone Courses


Construction
Late Winter 2013

# Stone Courses


**Construction April/May 2013**

**New York State Stormwater Management Design Manual**

Chapter 5: Green Infrastructure Practices

Section 5.3 Green Infrastructure Techniques

**Most Often Design Issue**

**Table 5.15 Material Specifications for Porous Pavement**

| Material | Specification | | | Notes |
|---|---|---|---|---|
| | Porous Asphalt | Porous Concrete | Permeable Paver | |
| Pavement | 3"-7" Bituminous mix ½" Nominal Maximum Aggregate Size<br>≥18% Air Voids (50 gyrations)<br>Draindown ≤0.3% | 4"-8" Portland Cement Type I or II (ASTM C 150), No. 8 (ASTM 33), Agg.:Cement Ratio 4:1 to 4.5:1 Water/Cement Ratio 0.28-0.35 | Varied shapes and sizes, 8%-10% surface opening, manufacturer specification, flow rate 5 in/hr or no less than 10% void | |
| Choker course | 4"-8" depth AASHTO No. 57 | None | 2" AASHTO No. 8 stone over 4" of No. 57 | Should be double-washed and clean and free of all fines |
| Filter Layer | 8"-12"<br>No. 2 stone | No. 2 stone | No. 2 stone | Depth based on structural, storage, and hydraulic requirements. Double-washed, clean, free of fines |

**NO ! – 1" to 1.5" Max. (Before Rolling)**

# Test Panel

**1000 SF = 10’x100’**

**Density Gauge Testing**

**6” Diameter Cores**

**Porosity Test**
**20 gal/minute**

**Practice Session(s) for Contractor, Inspection Team, Owners**

***Test Panel(s).*** A minimum of 1000 sq. ft. test panel will be required to be constructed. The test panel will be constructed at a location designated by the Engineer-in-charge or as directed in the contract documents, and will remain in place for the duration of the project to be used as a visual reference for acceptance of the pavement surface. Produce, deliver, and construct the test panel in accordance with this specification and the thicknesses specified in the contract documents. The final in-place air voids of each pavement layer shall be 16% to 22%.

***Test Panel Evaluation.*** The following will be performed on each Test Panel:

1. The owner will provide a density gauge operator that possesses a current Density Gauge Inspector Certification from The Associated General Contractors, New York State, or its equivalent. The density gauge operator will monitor the in-place density of the pavement course.
2. The owner will cut a minimum of three, 6 inch diameter, cores from each asphalt course prior to placing any subsequent courses. These cores will be used to determine:
    a. In-place air void of the asphalt course, and will be used to determine an acceptable density gauge correlation for use on the routine paving courses.
    b. Compacted thickness of the asphalt course.
3. Porosity Test. Allow a minimum of 24 hours after completion of the Top Course, before testing. Perform a porosity test at 3 locations chosen by the Engineer-in-charge. At each location, test the porosity for a minimum of 3 minutes. The test is accomplished by applying clean water at a measured rate of at least 5 gal/min over the surface, using a hose or other distribution device. Water used for the test shall be clean, free from suspended solids and deleterious materials and will be provided at no additional cost. All applied water shall infiltrate the test panel directly, without puddle formation or surface runoff, and shall be observed by the Engineer-in-charge.

**Paid under Separate Item Number (EA)**

# Stone Courses

## Test Panel #1 - August 2012

4A Gradation - OK

100% Fractured - NO

Since a Test Section.. the Gravel portions were Allowed to Remain

Placed Choker Course on One Half of Section


Test Panel #1 - August 2012

# Stone Courses

## Test Panel #1 - August 2012

Test Panel #1 - August 2012


**Test Panel #2 - April 2013**

**Reservoir Course – 4A's**

**No Choker Course – Contractors Option**

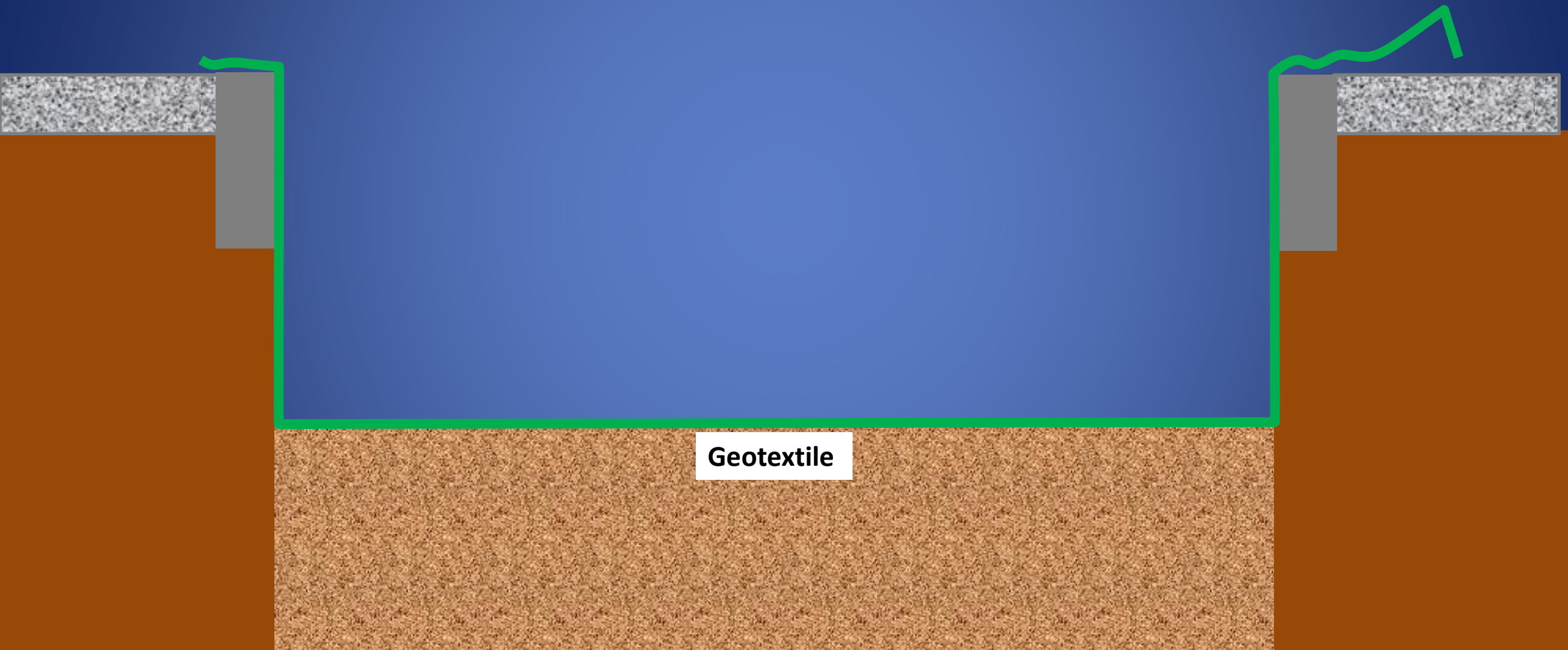

Not Quite Ready, 1 more
Vibratory Roll Needed - 10-13
Ton Double Steel Drum

# Ready to be Paved – Choker Course Installed – NYSDEC $M Beach Fall 2014

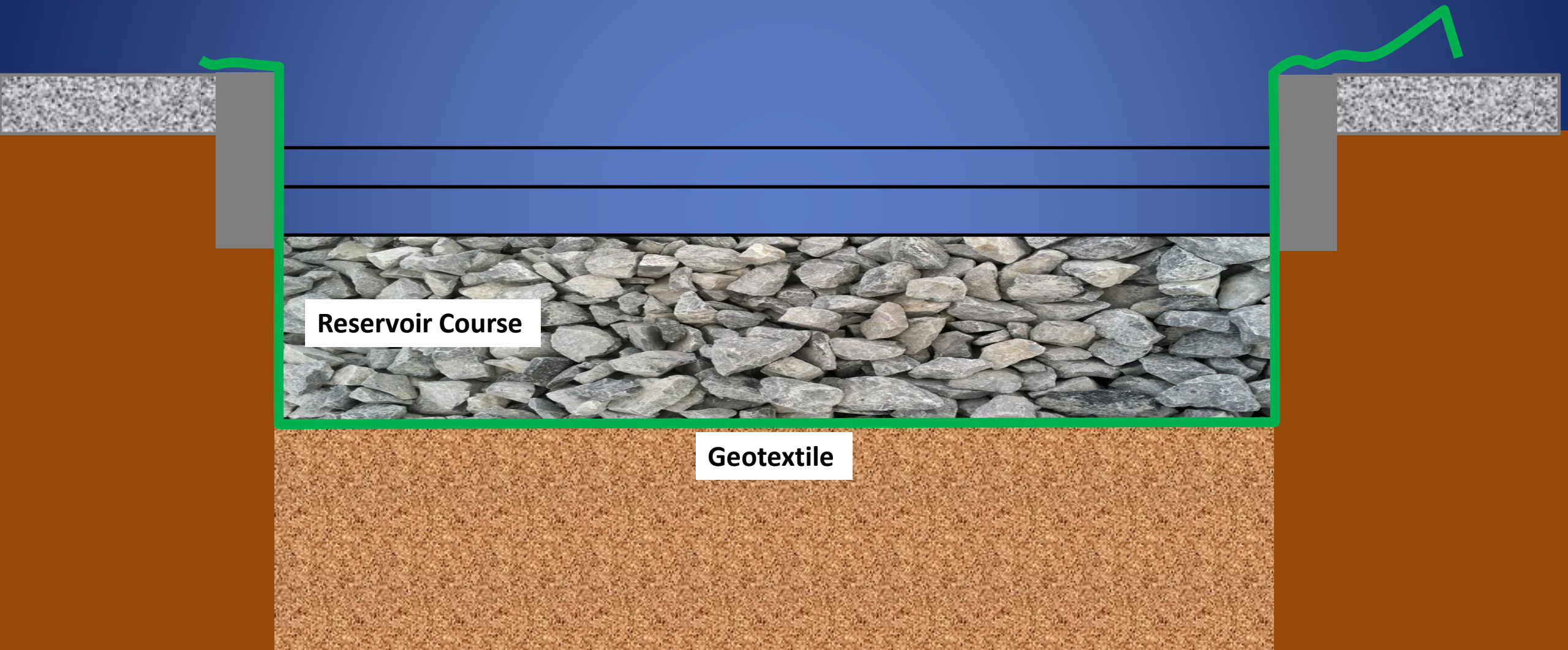

70 % to 80% - Choker Course
20% to 30% - Reservoir


70 % to 80% - Choker Course
20% to 30% - Reservoir
DD-90

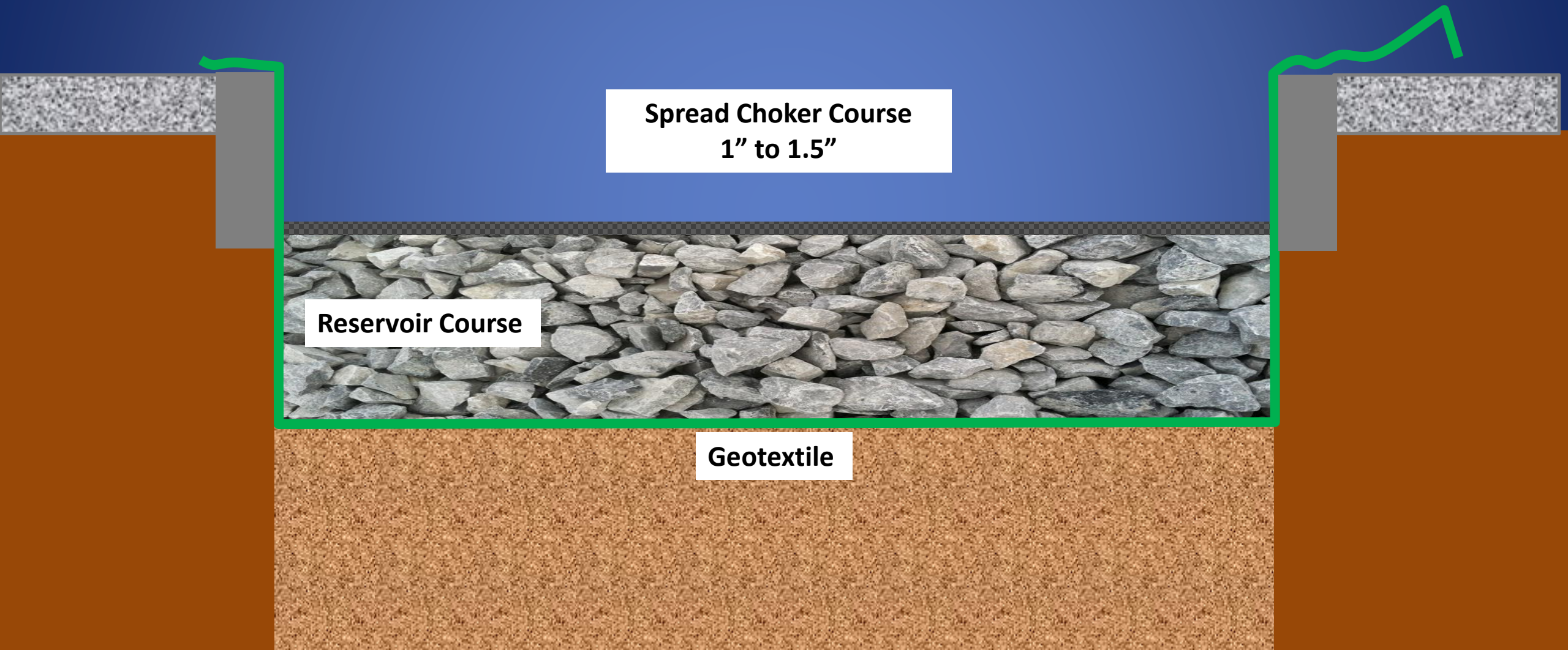
# Basic Installation



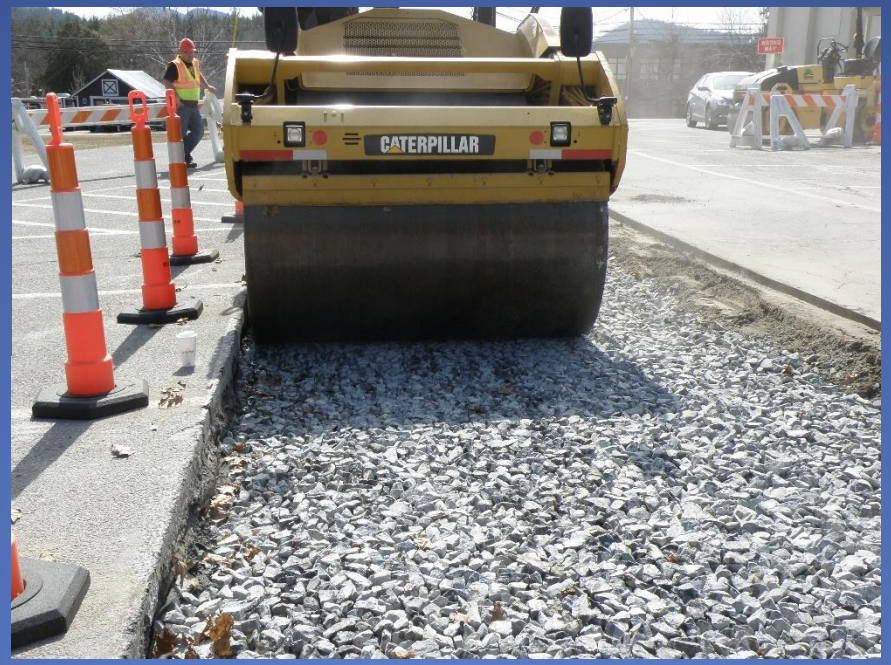
# Basic Installation



# Basic Installation



10 to 12 ton
ASPHALT Roller
On Low Vibrate

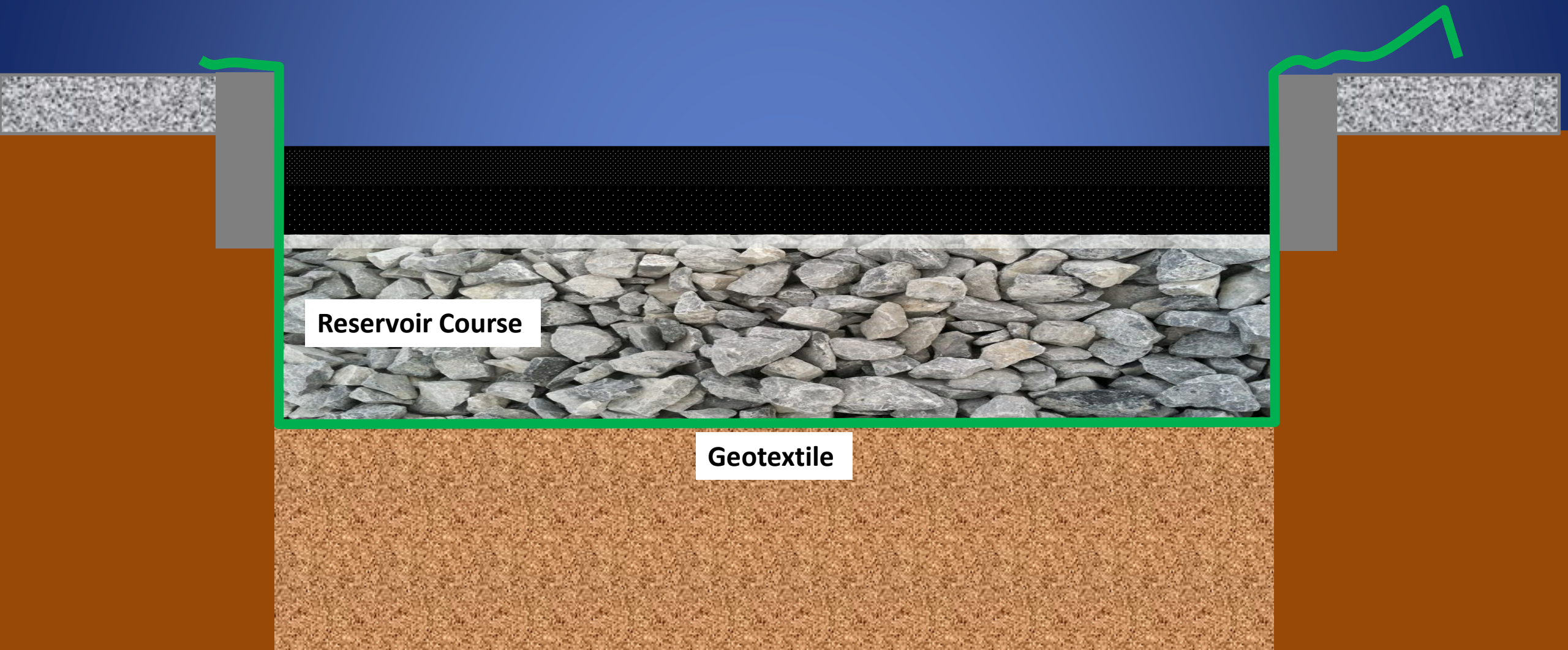



2 to 3 Passes
Visually See
70% Choker
30% Reservoir

Reservoir Course

Geotextile

# Basic Installation



# Choker Course Too Thick


Choker Course 4”-6” Thick
Not Desirable

# Rutting of 4”- 6” Thick Choker Course

# Specifications

**ITEM 623.120100WR – POROUS ASPHALT CRUSHED STONE STABILIZATION COURSE (CY)**
**ITEM 623.120200WR – POROUS ASPHALT CRUSHED STONE RESERVOIR COURSE (CY)**

**GRADATION:**

Material shall be graded in accordance with size designations shown in Table 703-4 from the NYSDOT Standard Specifications.

Stabilization Course – Size Designation No. 2

Reservoir Course - Size Designation No. 4A

**TABLE 703-4[1] SIZES OF STONE, GRAVEL AND SLAG**

| | Screen Sizes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Size Designation | 4 in | 3 in | 2 1/2 in | 2 in | 1 1/2 in | 1 in | 1/2 in | 1/4 in | 1/8 in | # 80 | #200[3] |
| Screenings[2] | - | - | - | - | - | - | 100 | 90-100 | - | - | 0-1.0 |
| 1B | - | - | - | - | - | - | - | 100 | 90-100 | 0-15 | 0-1.0 |
| 1A | - | - | - | - | - | - | 100 | 90-100 | 0-15 | - | 0-1.0 |
| 1ST | - | - | - | - | - | - | 100 | 0-15 | - | - | 0-1.0 |
| 1 | - | - | - | - | - | 100 | 90-100 | 0-15 | - | - | 0-1.0 |
| 2 | - | - | - | - | 100 | 90-100 | 0-15 | - | - | - | ~~0-1.0~~ 0.25% |
| 3A | - | - | - | 100 | 90-100 | 0-15 | - | - | - | - | 0-0.7 |
| 3 | - | - | 100 | 90-100 | 35-70 | 0-15 | - | - | - | - | 0-0.7 |
| 4A | - | 100 | 90-100 | - | 0-20 | - | - | - | - | - | ~~0-0.7~~ 0.25% |
| 4 | 100 | 90-100 | - | 0-15 ~~0.15~~ | - | - | - | - | - | - | 0-0.7 |
| 5 | 90-100 | 0-15 | - | - | - | - | - | - | - | - | 0-0.7 |

# Clean ? Washed ?

| TABLE 703-4[1] SIZES OF STONE, GRAVEL AND SLAG | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Screen Sizes | | | | | | | | | | |
| Size Designation | 4 in | 3 in | 2 1/2 in | 2 in | 1 1/2 in | 1 in | 1/2 in | 1/4 in | 1/8 in | # 80 | #200[3] |
| Screenings[2] | - | - | - | - | - | - | 100 | 90-100 | - | - | 0-1.0 |
| 1B | - | - | - | - | - | - | - | 100 | 90-100 | 0-15 | 0-1.0 |
| 1A | - | - | - | - | - | - | 100 | 90-100 | 0-15 | - | 0-1.0 |
| 1ST | - | - | - | - | - | - | 100 | 0-15 | - | - | 0-1.0 |
| 1 | - | - | - | - | - | 100 | 90-100 | 0-15 | - | - | 0-1.0 |
| 2 | - | - | - | - | 100 | 90-100 | 0-15 | - | - | - | ~~0-1.0~~ |
| 3A | - | - | - | 100 | 90-100 | 0-15 | - | - | - | - | 0-0.7 |
| 3 | - | - | 100 | 90-100 | 35-70 | 0-15 | - | - | - | - | 0-0.7 |
| 4A | - | 100 | 90-100 | - | 0-20 | - | - | - | - | - | 0-0.7 |
| 4 | 100 | 90-100 | - | 0-15 ~~0-15~~ | - | - | - | - | - | - | ~~0-0.7~~ |
| 5 | 90-100 | 0-15 | - | - | - | - | - | - | - | - | 0-0.7 |

0.25%

0.25%

**Testing In Lab at Quarry**

**0.25% passing #200 Sieve**

**Reasonably Achievable using the Washing Setup**

**Specification Modified for Future Projects**

## Rule of Thumb:

When Loading Trucks from Quarry Pile,
Only Scoop from the Upper 2/3 of the Pile

# ASPHALT

## PG 76-22ER (64E-22) with Fibers

# Beach Road Test Panel #1

**475.10130101 - Top Course Porous Asphalt Pavement with Mineral Fiber F3**
**475.10190101 - Top Course Porous Asphalt Pavement with Mineral Fiber F9**
**475.01190101 - Binder Course Porous Asphalt Pavement F9**

## DESCRIPTION:

Furnish and place Porous Asphalt Pavement courses in accordance with the contract documents as directed by the Engineer-in-Charge. The top course mixture requires the use of Mineral Fibers as outlined in this specification. A Test Panel(s) will be required as outlined in this specification and other contract documents.

## MATERIALS:

The materials and composition for the Porous Asphalt Pavement mixtures shall meet the requirements specified in §401-2 Materials, except as noted herein.

Formulate a job mix formula (JMF) that satisfies the design limits listed below and submit it to the Regional Materials Engineer (RME), at least one week prior to placement of the test section.

**Porous Asphalt Pavement Mixtures Gradation Requirements**

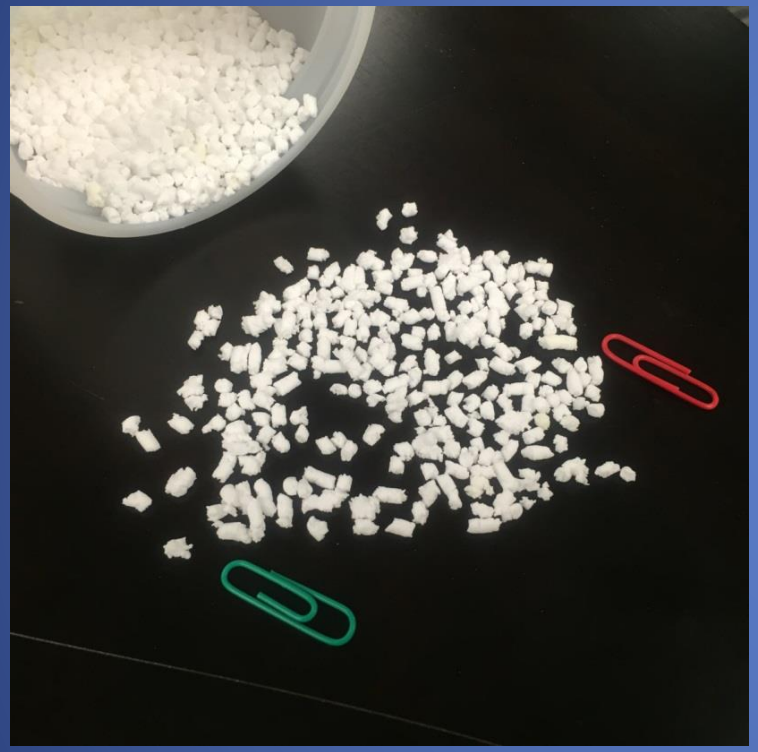
| Screen Sizes | Top Course | Binder Course |
|---|---|---|
| | General Limits % Passing | General Limits % Passing |
| 2 inch | --- | 100 |
| 1 ½ inch | --- | 75-100 |
| 1 inch | --- | 55-80 |
| 3/4 inch | 100 | --- |
| 1/2 inch | 85-100 | 23-42 |
| 3/8 inch | 55-75 | 5-20 |
| No. 4 | 10-25 | 2-15 |
| No. 8 | 5-10 | --- |
| No. 16 | --- | --- |
| No. 30 | --- | --- |
| No. 200 | 2-4 | --- |

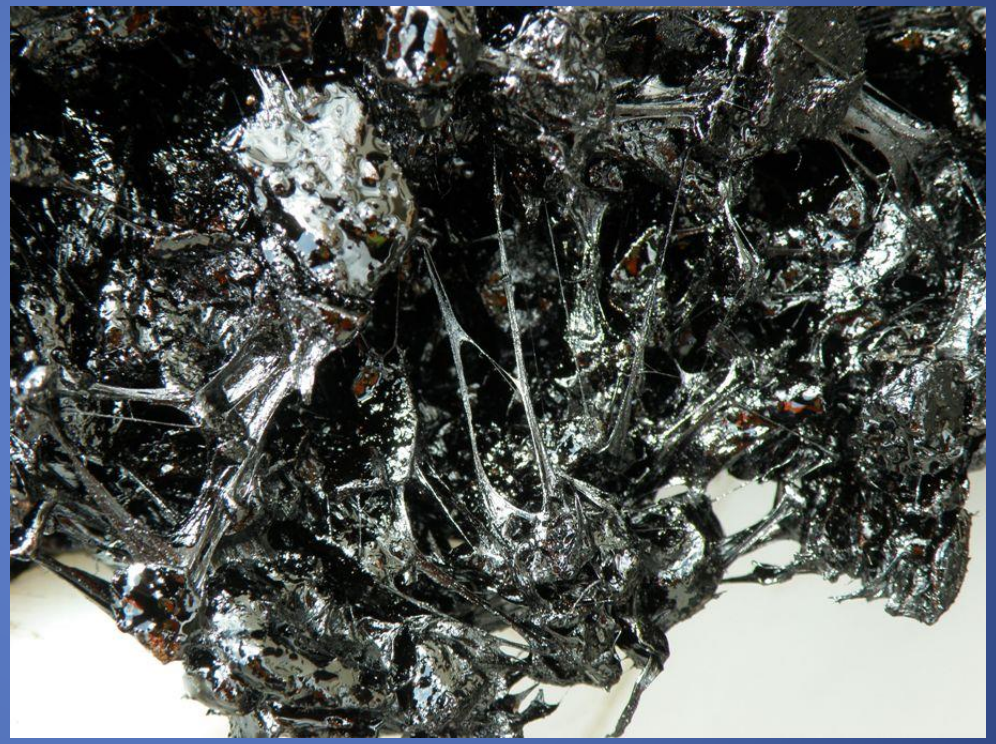

Notice Anything Wrong Here ?


Project Designed with No Top Course

# Polymer Additive / Fibers

Styrene – Butadiene – Styrene (SBS)





2% to 6% by Weight - Added to Asphalt Binder

Varies with Grade of Original Crude

# Fibers

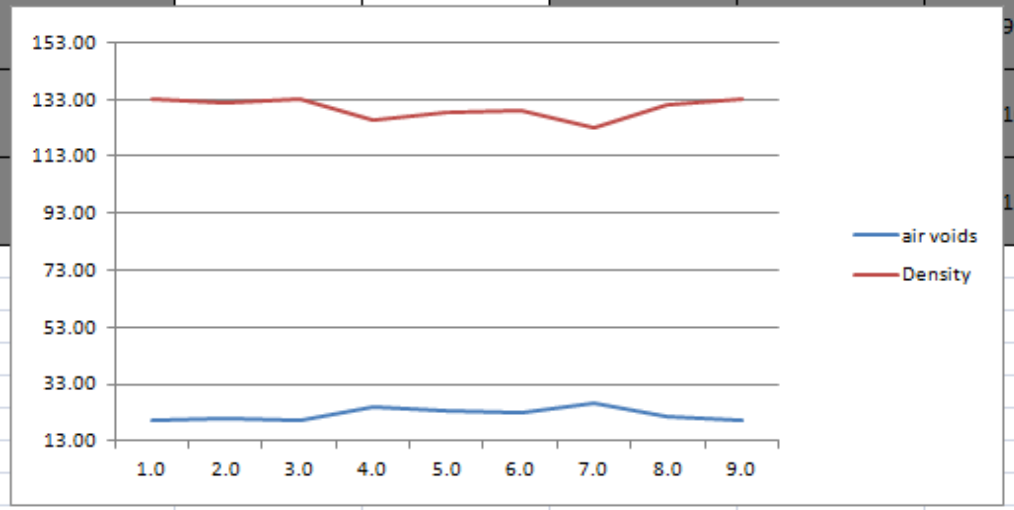
## Basalt, Cellulose, Blends including Aramid

- Help Control Drain Down
- Added at Dry Mix Stage Can be 0.3% to 0.6% by Weight

**Rule of Thumb:**

MUST Increase Dry Mix Time By 20 seconds

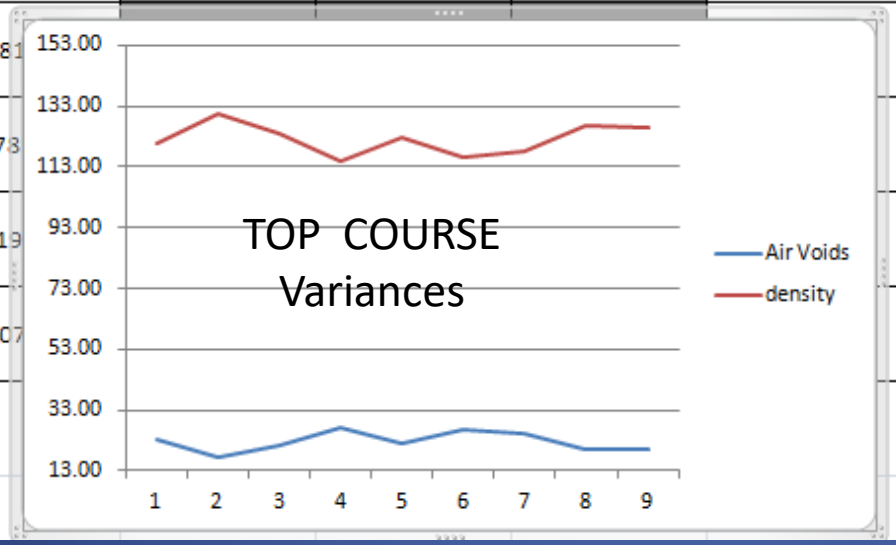
| B - Calculated mass of the dry sealed specimen, g | C - Final mass of the specimen after removal from sealed bag, g | E - Mass of the sealed specimen underwater, g | Ratio of mass of dry to to the mass of the bag | F - Apparent specific gravity of the plastic bag, provided by the manufacturer | Specimen bulk specific gravity, Gmb | Maximum specfic gravity of the mixture, Gmm | Specimen air voids, % | Comments | Density pounds/cf divided by factor of 7 |
|---|---|---|---|---|---|---|---|---|---|
| 4882.9 | 4827 | 2544.5 | 85.8843 | 0.7170 | 2.1354 | 2.681 | 20.35 | None | 133.2 |
| 4386.6 | 4330.2 | 2261.6 | 76.7766 | 0.7322 | 2.1144 | 2.681 | 21.13 | None | 131.9 |
| 5469.9 | 5413.1 | 2851.8 | 96.1563 | 0.7000 | 2.1337 | 2.681 | 20.41 | None | 133.1 |
| 4062.4 | 4006.3 | 2000 | 71.5429 | 0.7408 | 2.0166 | 2.681 | 24.78 | Core slightly damaged during drying process | 125.8 |
| 2791.1 | 2764.9 | 1406.2 | 105.5305 | 0.6844 | 2.0532 | 2.681 | 23.42 | None | 128.1 |
| 3251.8 | 3195 | 1632.2 | 56.5540 | 0.7657 | 2.0675 | 2.681 | 22.88 | Core severly damaged during drying process | 129.0 |
| | | | | | 9684 | 2.681 | 26.58 | Core severly damaged during drying process | 122.8 |
| | | | | | 1024 | 2.681 | 21.58 | None | 131.2 |
| | | | | | 1344 | 2.681 | 20.39 | None | 133.2 |




BASE COURSE

# Beach Road Test Panel #1

| l mass of ecimen emoval aled bag, g | E - Mass of the sealed specimen underwater, g | Ratio of mass of dry to to the mass of the bag | F - Apparent specific gravity of the plastic bag, provided by the manufacturer | Specimen bulk specific gravity, Gmb | Maximum specfic gravity of the mixture, Gmm | Specimen air voids, % | Comments | Density pounds/cf divided by factor of 1 |
|---|---|---|---|---|---|---|---|---|
| 41.4 | 1403.7 | 52.2451 | 0.7729 | 1.9337 | 2.529 | 23.54 | None | 120.7 |
| 01.6 | 1602 | 119.2885 | 0.6616 | 2.0867 | 2.529 | 17.49 | None | 130.2 |
| 53.7 | 1694.3 | 60.2740 | 0.7595 | 1.9834 | 2.529 | 21.57 | None | 123.8 |
| 73.6 | 937.6 | 79.4444 | 0.7277 | 1.8411 | 2.529 | 27.20 | None | 114.9 |
| 37.6 | 1571.1 | 57.1996 | 0.7646 | 1.9632 | 2.529 | 22.37 | None | 122.5 |
| 66.8 | 181 | | | | | 26.33 | None | 116.3 |
| 86.8 | 73 | | | | | 25.29 | None | 117.9 |
| 69.6 | 19 | | | | | 19.88 | None | 126.4 |
| 61.1 | 207 | | | | | 20.36 | None | 125.7 |




TOP COURSE

**Air Voids = (Gmax-Gtest) / Gmax**

| ulk vity, | Maximum specfic gravity of the mixture, Gmm | Specimen air voids, % | Comments | Density pounds/cf divided by factor of 1 |
|---|---|---|---|---|
| | 2.529 | 23.54 | None | 120.7 |
| | 2.529 | 17.49 | None | 130.2 |
| | 2.529 | 21.57 | None | 123.8 |
| | 2.529 | 27.20 | None | 114.9 |
| | 2.529 | 22.37 | None | ourse122.5 |

# Density/Air Void Ratio Issue & Solution

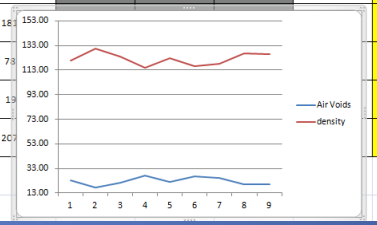
## Results of First Test Panel

### Inconsistency in Asphalt Content

**15.5%, 10.1%, 7.6%, 8.6%**

**Others Correct at 5.9% - 6.2%**

| mass of ecimen emoval aled bag, g | E - Mass of the sealed specimen underwater, g | Ratio of mass of dry to to the mass of the bag | F - Apparent specific gravity of the plastic bag, provided by the manufacturer | Specimen bulk specific gravity, Gmb | Maximum specfic gravity of the mixture, Gmm | Specimen air voids, % | Comments | Density pounds/cf divided by factor of 1 |
|---|---|---|---|---|---|---|---|---|
| 41.4 | 1403.7 | 52.2451 | 0.7729 | 1.9337 | 2.529 | 23.54 | None | 120.7 |
| 01.6 | 1602 | 119.2885 | 0.6616 | 2.0867 | 2.529 | 17.49 | None | 130.2 |
| 53.7 | 1694.3 | 60.2740 | 0.7595 | 1.9834 | 2.529 | 21.57 | None | 123.8 |
| 73.6 | 937.6 | 79.4444 | 0.7277 | 1.8411 | 2.529 | 27.20 | None | 114.9 |
| 37.6 | 1571.1 | 57.1996 | 0.7646 | 1.9632 | 2.529 | 22.37 | None | 122.5 |
| 66.8 | 18 | | | | | 26.33 | None | 116.3 |
| 86.8 | 73 | | | | | 25.29 | None | 117.9 |
| 69.6 | 19 | | | | | 19.88 | None | 126.4 |
| 61.1 | 207 | | | | | 20.36 | None | 125.7 |




**Data = Unreliable**

**Aggregate Gradation Variations?** No.

**Draindown ? – No.**

**Issue was due to Clumping of the Fibers**

**Solution** - Increase Dry Mix Time by 15- 20 seconds during Production to better distribute the fibers

# Improperly Mixed Fibers

# Improperly Mixed Fibers


Top Course
Test Panel #2 - April 2013

Test Panel #2 - April 2013

# 2nd Test Panel - Gauge Calibration

| Specimen number | Lab Results: Specimen bulk specific gravity, Gtest | Specimen Density, lbs/ft³ | Troxler Model 3430 Serial Number 23531 — Field Tests: Gauge Reading, lbs/ft³ | Correction Factors: Correction Factor, lbs/ft³ |
|---|---|---|---|---|
| Core 1 - Top | 1.9535 | 121.90 | 117.7 | 4.20 |
| Core 2 - Top | 2.0140 | 125.67 | 122.3 | 3.37 |
| Core 3 - Top | 1.9616 | 122.40 | 117.5 | 4.90 |
| Core 4 - Top | 1.9358 | 120.80 | 117.2 | 3.60 |
| Core 5 - Top | 1.9849 | 123.86 | 121.2 | 2.66 |
| Core 6 - Top | 1.9443 | 121.33 | 116.8 | 4.53 |
| Core 7 - Top | 2.0032 | 125.00 | 122.4 | 2.60 |
| Core 8 - Top | 1.9914 | 124.26 | 120.8 | 3.46 |
| Core 9 - Top | 1.9779 | 123.42 | 117.5 | 5.92 |
| | | | Ave Correction Factor | 3.91 |
| | | | **Project Target Density, lbs/ft³** | **123.5** |

**1** **x 62.4 =** **Minus Gauge** **=**

$G_{max}$ = 2.52 for Mix (from Plant)

$G_{target}$ = 2.52 – (19% x 2.52) x 62.4

Minus the Correction Factor =

# Base Course Test

**Placed 7.5” Loose**
**6” Rolled**

| Specimen number | Specimen bulk specific gravity, Gmb | Specimen air voids, % | |
|---|---|---|---|
| 1 - Base - Whole | 2.1337 | 20.41 | |
| 1 - Base - Top | 2.1569 | 19.55 | 5.5% |
| 1 - Base - Bottom | 2.1269 | 20.67 | |
| 2 - Base - Whole | 2.0252 | 24.46 | |
| 2 Base - Top | 2.0754 | 22.59 | 1.1% |
| 2 - Base - Bottom | 2.0823 | 22.33 | |
| 3 - Base - Whole | 2.1000 | 21.67 | |
| 3 - Base - Top | 2.1230 | 20.81 | 3.1% |
| 3 - Base - Bottom | 2.1055 | 21.47 | |
| 4 - Base - Whole | 2.0765 | 22.55 | |
| 4 - Base - Top | 2.0243 | 24.49 | 13.3% |
| 4 - Base - Bottom | 2.1118 | 21.23 | |

# Fiber Alternative
# Warm Mix Asphalt



COMMUNICATIONS

Videos

Publications

- Asphalt Pavement Magazine
- Asphalt Pavement Digital Archive
- Asphalt Pavement/HMAT Digital Archive (pre May/June 2018)
- Publication Department Contacts

Newsroom

- Asphalt in the News
- NAPA News

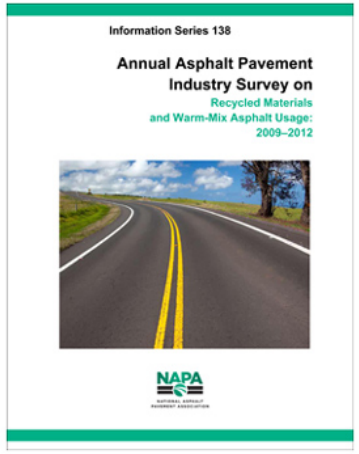
NAPA Online Store



## Warm-Mix Asphalt Use Reaches New Heights

*New NAPA/FHWA Survey Finds Nearly One-Fourth of Asphalt Tonnage Produced in 2012 Used Energy-Saving Warm Mix; Increased Use of Recycled Materials Also Quantified*

Lanham, Md. — In the latest survey of the use of recycled materials and warm-mix asphalt usage by the U.S. asphalt pavement industry, nearly a quarter of all asphalt mixtures produced in the 2012 construction season were produced using warm-mix asphalt (WMA) technologies.




The survey, conducted by the National Asphalt Pavement Association (NAPA) under contract to the Federal Highway Administration (FHWA), found that the 1,141 U.S. asphalt plants queried produced about 86.7 million tons of WMA during the 2012 construction season. This marks a 416 percent increase in the use of warm mix since the survey was first conducted in 2009. The full survey results are available at www.AsphaltPavement.org/recycling.

Because WMA is produced at a lower temperature than traditional asphalt mixes, it uses less energy to produce, reduces emissions, improves worker safety, and offers construction benefits. U.S. Secretary of Transportation Anthony Foxx commented in January during the 2014 Transportation Research Board Annual Meeting that the use of WMA is expected to save $3.6 billion in energy costs alone by 2020.

Asphalt pavements also continue to use increasing amounts of recycled and reclaimed materials. The survey found that about 68.3 million tons of reclaimed asphalt pavement (RAP) and 1.86 million tons of recycled asphalt shingles (RAS) were used in new asphalt pavement mixes in the United States during in 2012. For the first time since the start of this survey in 2009, the amount of RAP and RAS used by

# Production, Transit, and Placement Temperature

# Production, Transit, and Placement Temperature

# Production, Transit, and Placement Temperature

- **Surface Temperature Not Valid for Initial Truck Acceptance**
- **Obtain Avg. Temp from below surface “crust”**
- **Use Internal Thermometer on first few loads**

**Rule of Thumb:**

Expect a 40 - 60 degree difference Between Surface and Internal Temp on the **Placed Mat**


HOLD
°F
226
MAX 233
°C/°F
weber
262°F
°F/°C

# Production, Transit, and Placement Temperature

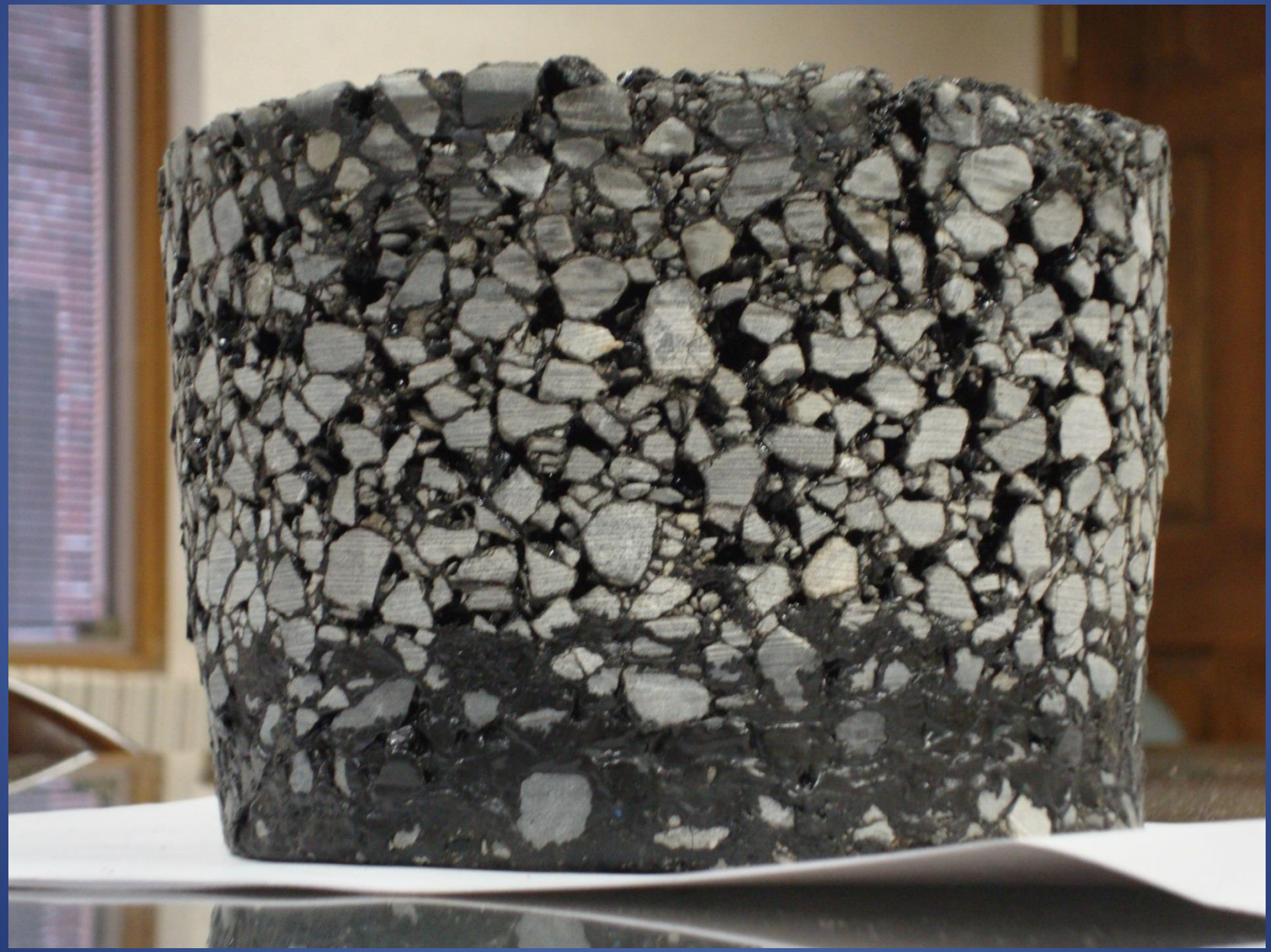
**EASY -> CALIBRATE TEMP. DEVICES IN ICE WATER AND BOILING WATER**

## Rule of Thumb:

**Watch out for the roller**


weber
66.2
°F/°C
GENERAL
°F
60.8
IRT207
°C/°F
HOLD
°F
66.5
C/F

# Draindown



# Production, Transit, and Placement Temperature

# Production, Transit, and Placement Temperature

# Asphalt Drain Down

# Video Asphalt Drain Down

# Production, Transit, and Placement Temperature

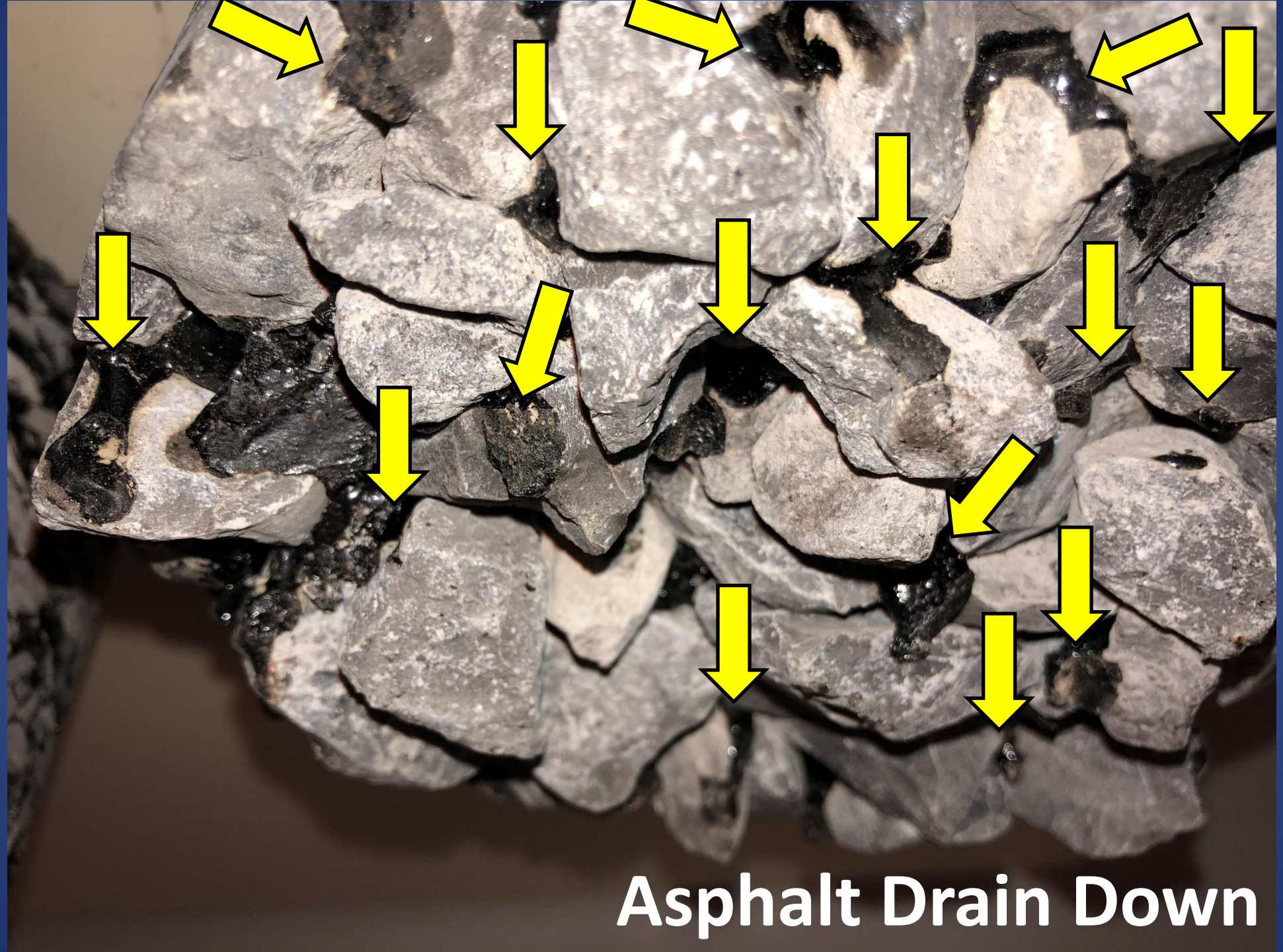
# Placed at 5” (Loose)

From Driving Lane

From Center of Parking Space


Forensic Project

# Asphalt Drain Down


Asphalt Drain Down

# Estimated Placement Temperature 350*F +

# Lake George Asphalt Drain Down Test

**PG 64-22 P**
**w/ ER 60%**

4/8/2013
LOT 1-A
TEST STRIP

**POROUS BINDER FOR BEACH ROAD**

## BINDER

| | @ 290 DEG. F | @ 327 DEG F. |
|---|---|---|
| wt of sample = | 1051.3 | 1447.2 |
| tare wt of pan = | 395.4 | 395.2 |
| end wt of pan = | 396.4 | 397.5 |

$$\frac{\text{end wt of pan} - \text{start wt of pan}}{\text{wt of sample}}$$

| = | 0.10 | 0.20 |
|---|---|---|

AVE DRAINDOWN 0.15

**BLEND 1 - POROUS TOP** **TOP**

TEST STRIP FOR BEACH ROAD (#2)
4/9/2013

0.6% FIBERS

**Fiber Spec Was**
**0.4% +/-**

**DRAIN DOWN TEST**

| | @290deg f | @ 327 deg f |
|---|---|---|
| wt of sample = | 1113.7 | 1108.1 |
| tare wt of pan = | 395.2 | 395.4 |
| end wt of pan = | 395.5 | 396.3 |

$$\frac{\text{end wt of pan} - \text{start wt of pan}}{\text{wt of sample}}$$

| = | 0.03 | 0.08 |
|---|---|---|

**0.05**

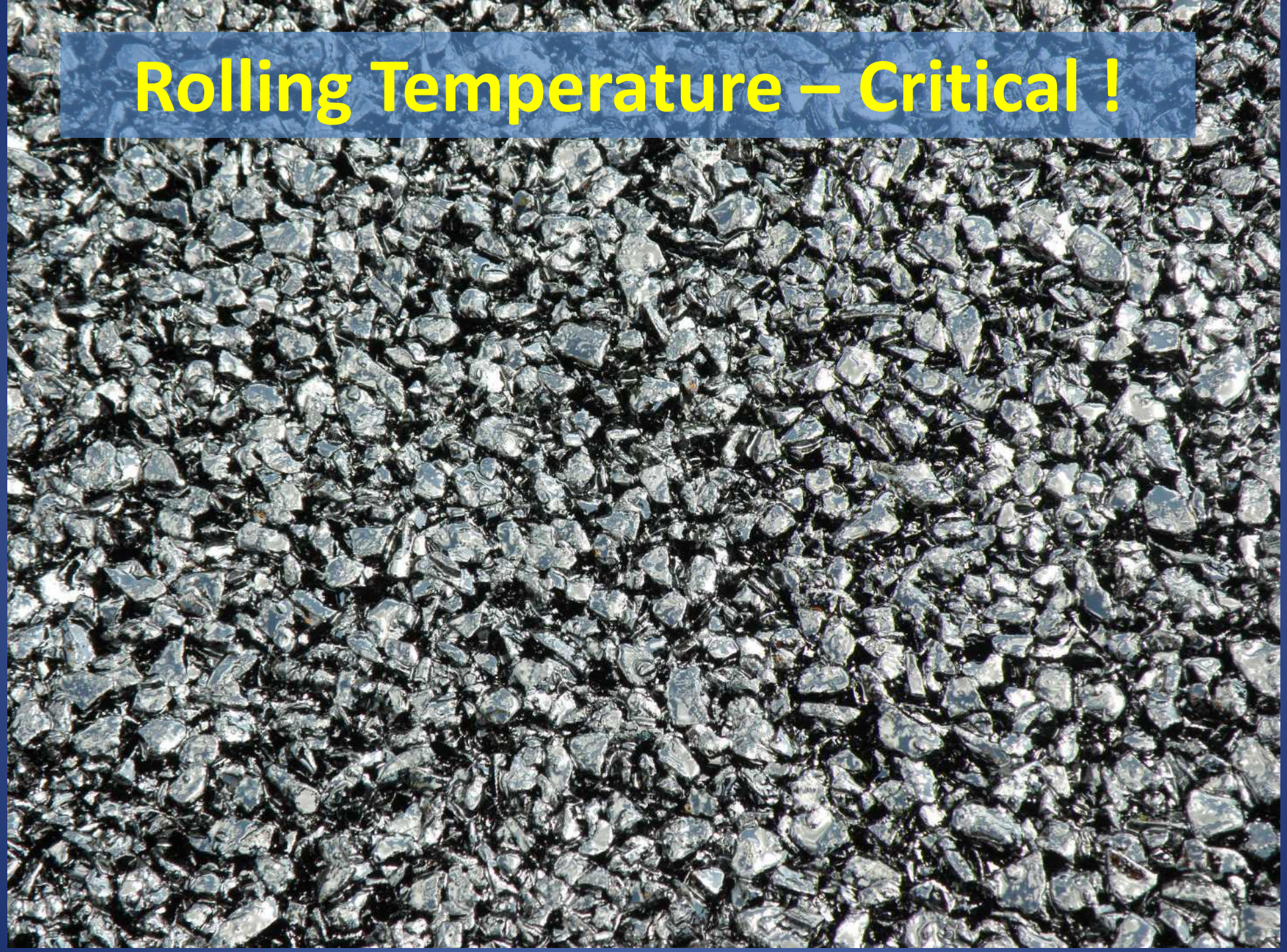
**PG 76-22 P**
**w/ ER 60%**

# Careful Cleaning Plant Between Batches

# Careful Cleaning Plant Between Batches

# Rolling

# Rolling Temperature – Critical !



# Rolling Temperature – Critical !

- Ambient Temperature 50 to 70 degrees F.
- Ideally - Wind – 0 to 3 mph
- Beware - Asphalt surface cooling to quick
- No Paving Top Course under 50 degrees F.
  (Colder Weather Paving Process is Different)

- Hot Weather and Cold Weather Rolling
  - ❑ Heavy Water Usage

- Cooling time to Finish Rolling = Approx. 4 hours

# Rolling Temperature – Critical !

- Binder Course – 200 – 240 (260 F. Cooler air temps)
- Top Course – 200 - 240 F.
- Finish Rolling - 110 - 140 F. - Top,
  - 140 – 150 F. - Binder
- 4 to 6 Passes with 10 to 12 Ton Roller OK (Static)
- Increases in Density of 1 to 2 lbs/CF up to 5 - 6 passes
  - **Density Spike of 4 to 5 lbs/CF between 120 and 140 F.**
- 1 to 3 Passes with 3.5 to 5 Ton Roller to Finish

# Rolling Temperature – Critical !

**Must Make Two (2) Passes with 10 -12 Ton Roller**
**Between 110 and 140 Degrees F.**

**Once Top Course is 100 Degrees F.**
**All Compaction, Jointing, and Line Removal Stops**
**Even if Vibrated**

**Rollers to be Operated SLOWLY**
**Annoyingly Slow**

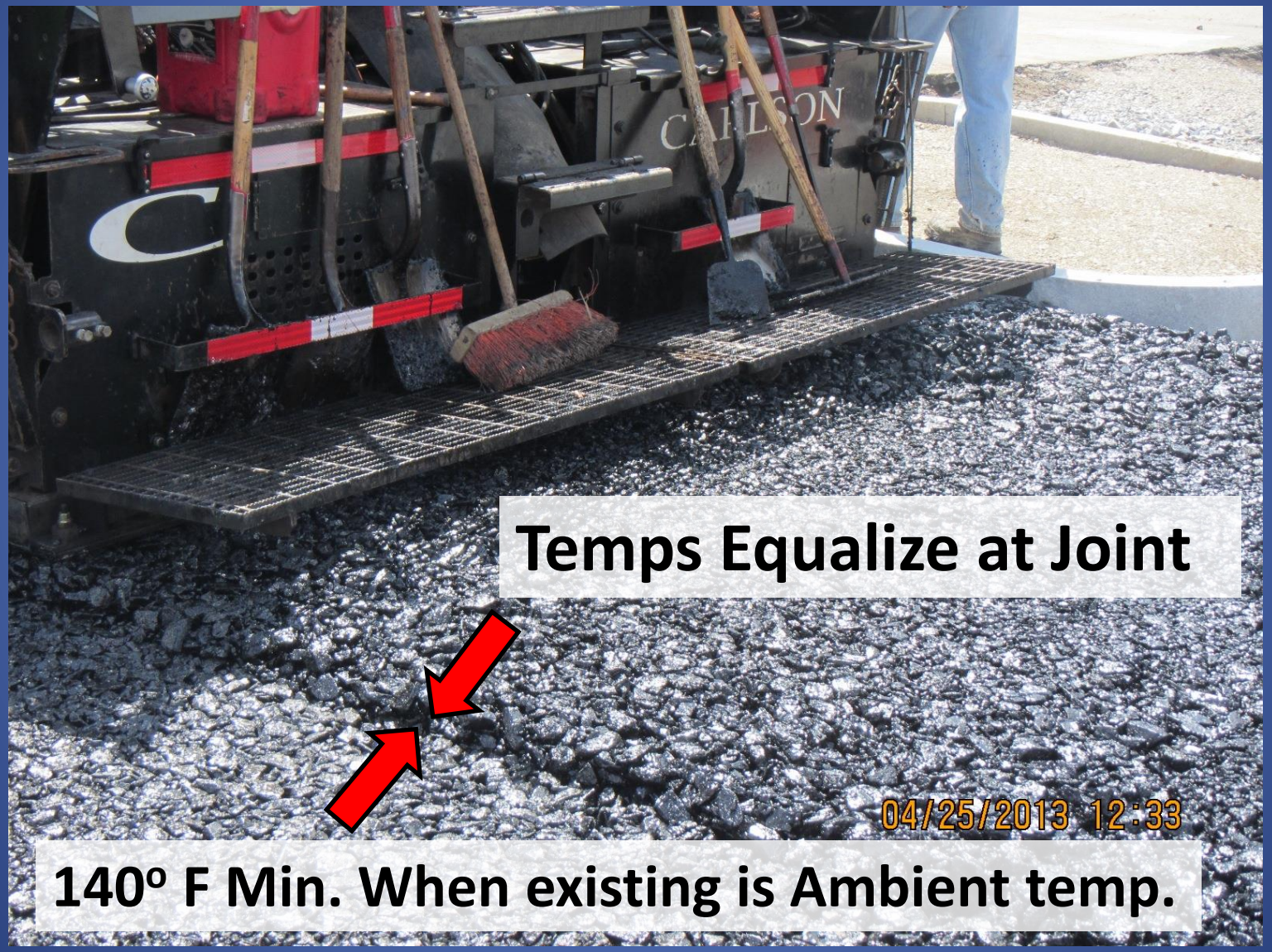
# Rolling Temperature – Critical !


vorites
raries
Documents
Downloads
Music
ictures
ideos
My Videos
Public Vid
Download
megroup
nputer
indows7_C
(J:)
bany CAD
arketing (M
novo_Rec
bany Shar
ared Stora
bject Data
adyshare

# Cones to Mark Roller Limits

# Cold Joints

# Cold Joints


Temps Equalize at Joint
04/25/2013 12:33
140° F Min. When existing is Ambient temp.

# Short Runs – Protect the Base Course

# Use of Synthetic Materials

# Use of Synthetic Materials

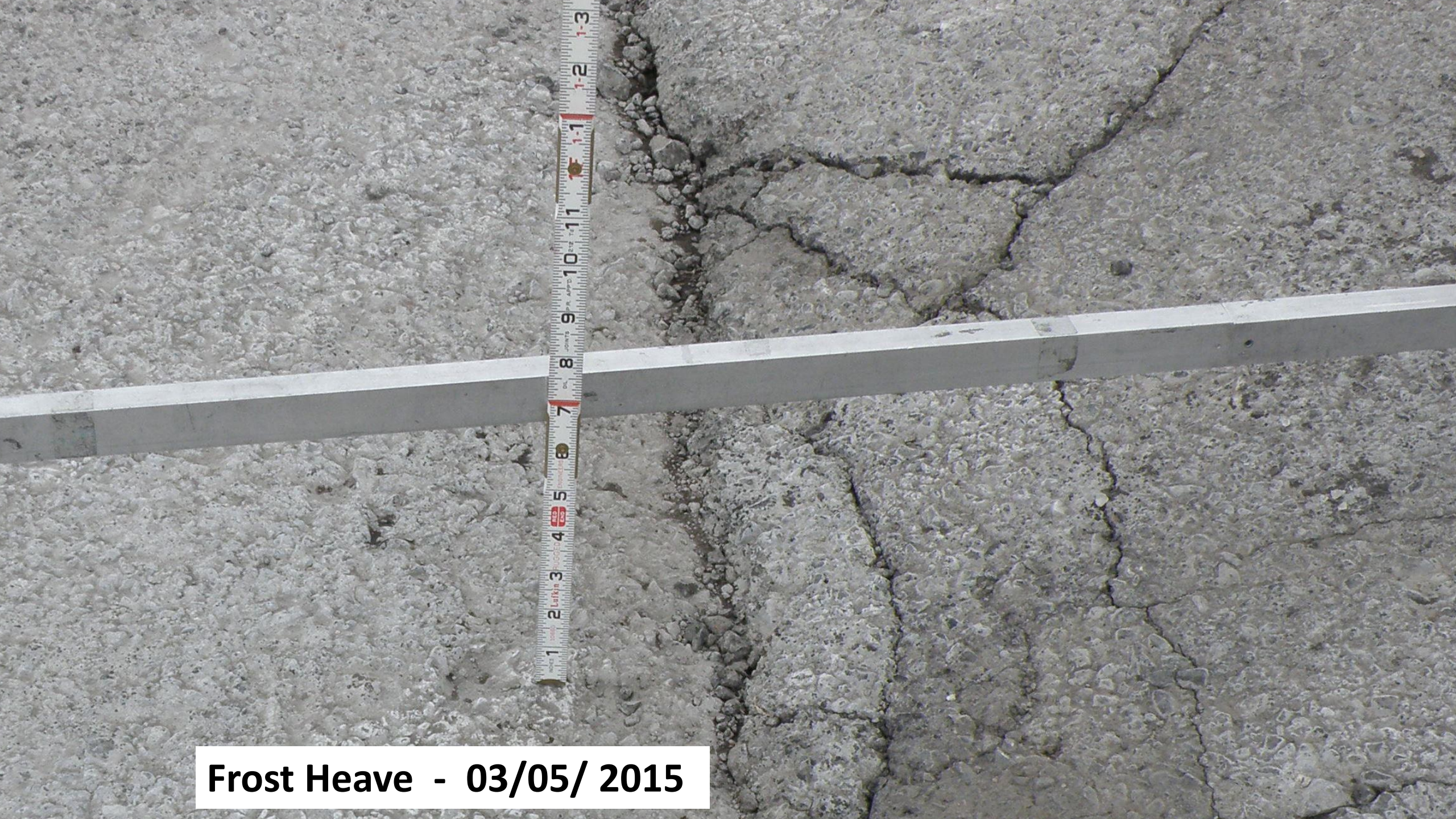
# Use of Synthetic Materials

# Geotextiles

SUNY Albany
August 2015


Frost Heave - 03/05/ 2015


**Frost Heave - 03/05/ 2015 – Project Specifics Unknown**



Frost Heave - 03/05/ 2015


SPEED
LIMIT
15
Lateral Support

# What is Missing ?

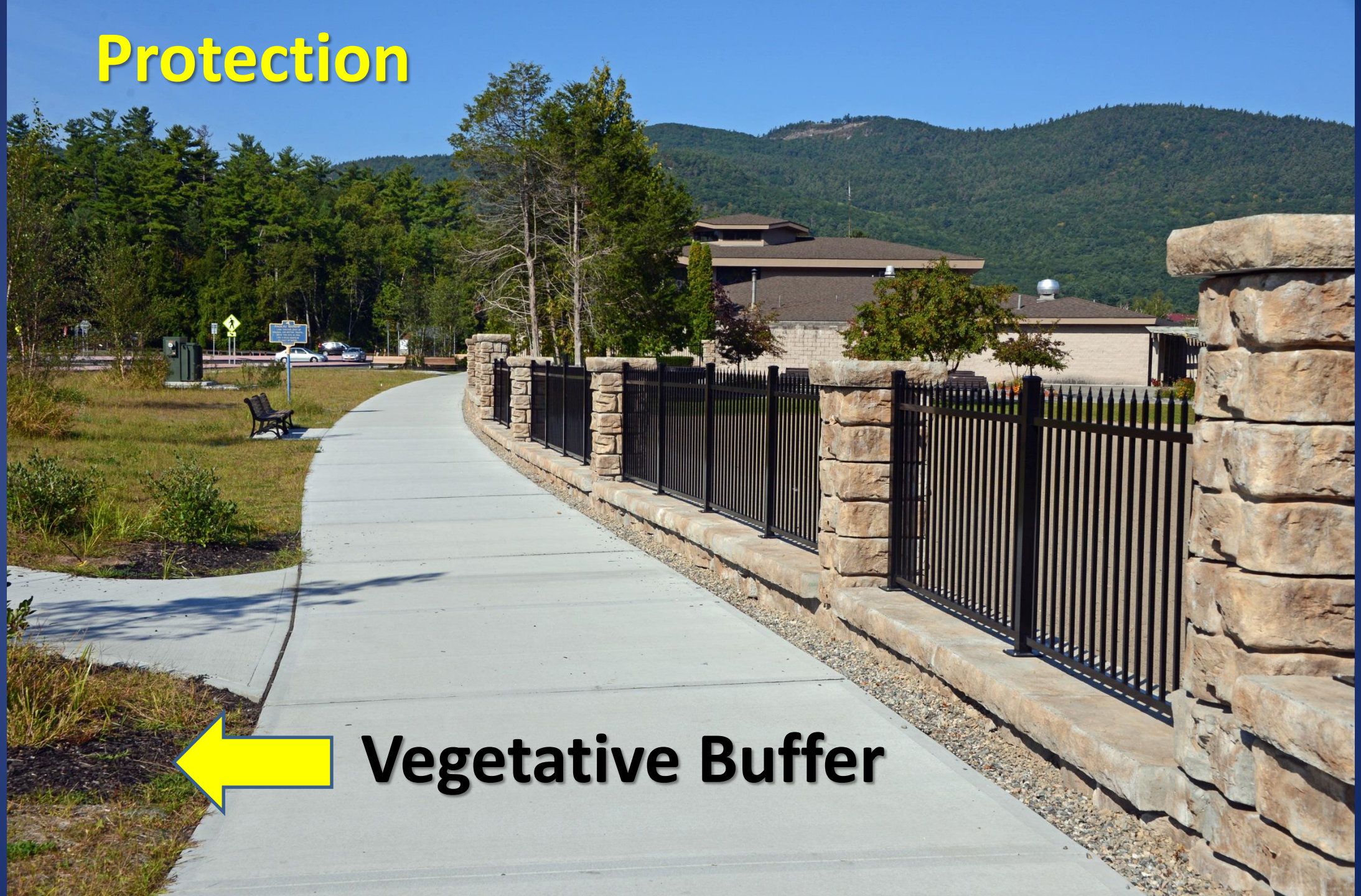

Lateral Support Missing ------>
Curb Deleted By Project
Owner to Cut Costs
Edge Cracking
Creep
Contamination Eminent

# Protection

## Wall

- Limit Access to Beach
- Sand Break
- Aesthetics
- Limit Access to Lake - Winter

# Protection

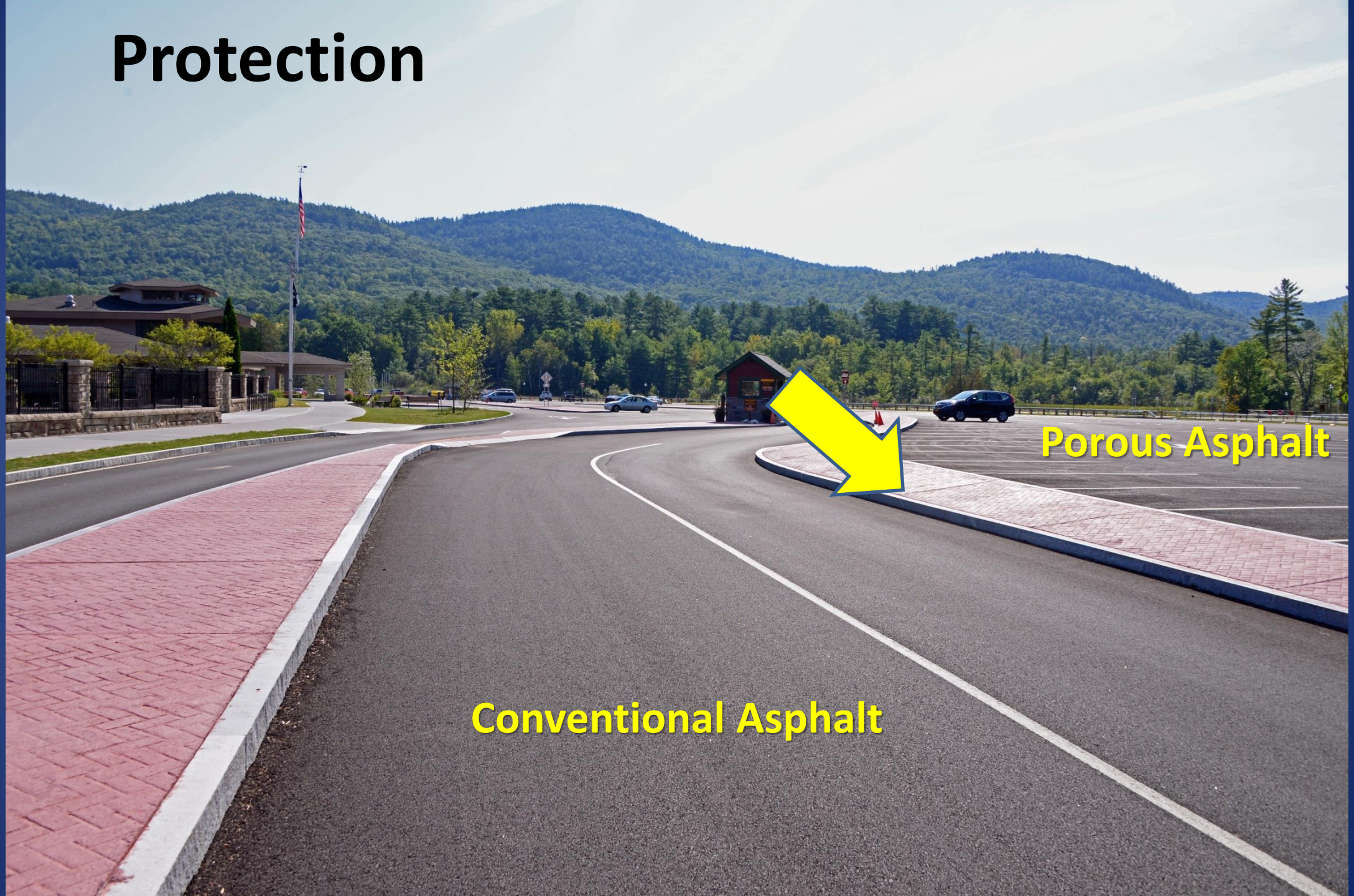


# Protection

Wall


Protection
Walls, Buffers, Windbreaks

# Protection



# Maintenance

**Vacuum**

## ~~Sweeping~~ Porous Pavement

Research demonstrates that vacuum sweepers are the best option when sweeping porous pavement

The use of porous pavement surfaces for parking lots, driveways, alleys, and footpaths as an effective best management practice to control stormwater runoff has been growing at a double digit rate in the United States in recent years. The long-term success of porous pavement systems to promote maximum water flow depends on proper installation, maintenance and cleaning practices – including regular sweeping with a pure vacuum sweeper.

Brian Giles, sweeper products manager at Elgin Sweeper, says Elgin has participated in various research programs with major universities and municipalities across the United States

porous subsurface. The blocks have a gap between them filled with loose, sandy filler which allows water to percolate through the gaps. Giles says the use of interlocking pavers is growing in the United States, especially in low-speed (under 45 mph) traffic and parking areas and in high-pedestrian areas.

### Plugging

Porous asphalt, porous concrete, and interlocking paver block surfaces can all become plugged with fine debris – mixtures of silt and oils – that can stop the percolating action and negate the purpose of the system. The first step in retaining the porous nature of the sur-

If pavers are routinely cleaned, the depth of plugging can generally be limited to half an inch. The most effective way to restore the percolation of paver surfaces is to remove the top layer of granular filler that is contaminated. Clean filler is then reapplied.

Several industry studies have shown that both surface types will plug, to varying degrees, with silt, fine clay, cement derivatives, and decomposed plant material. Maintaining and cleaning porous pavement surfaces to prevent the buildup of these sediments requires a different approach than the one used for traditional pavement.

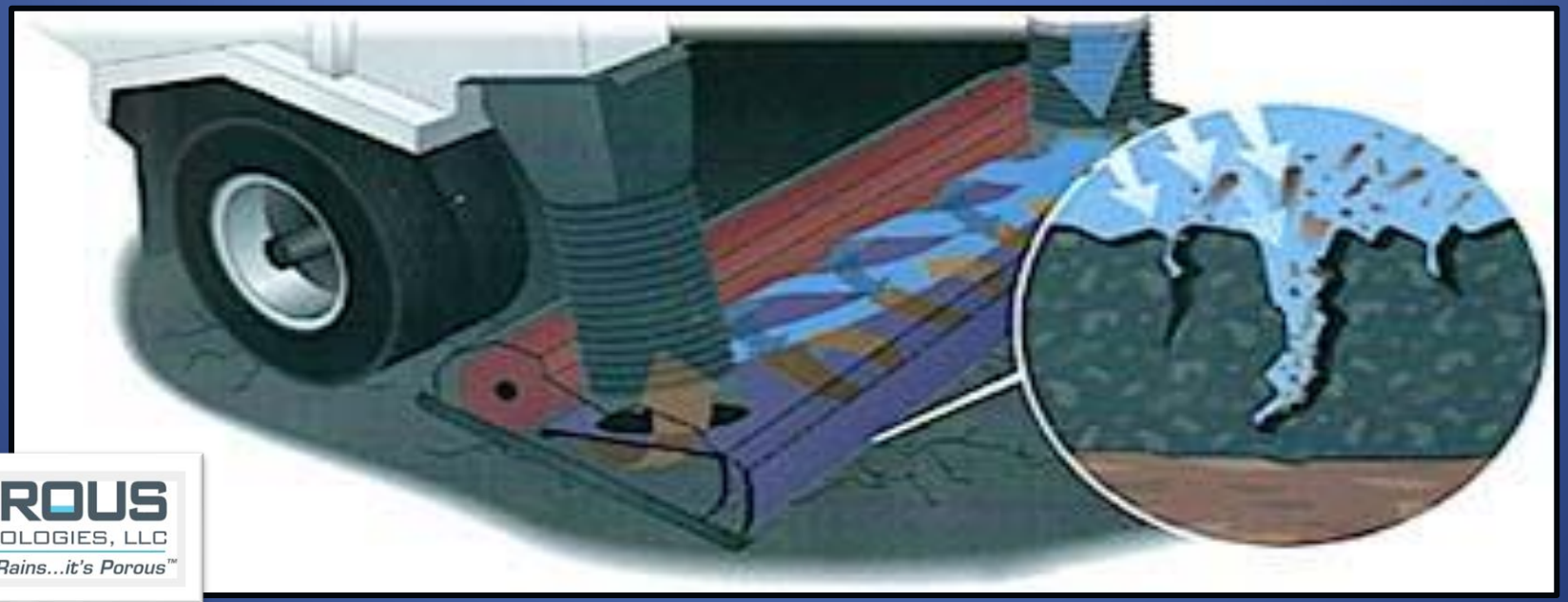



- Design Offsite Protection Systems into your project
- Maintain Vegetated Areas
- Vacuum  2 - 3 X / Year
- Slope Vegetated Areas Away from Roadway
- Use Sod to Establish Turf
- Education – Public and Municipal
- Deep Clean Promptly if Accident Occurs

Expect Continued Improvements in Maintenance Options and Equipment

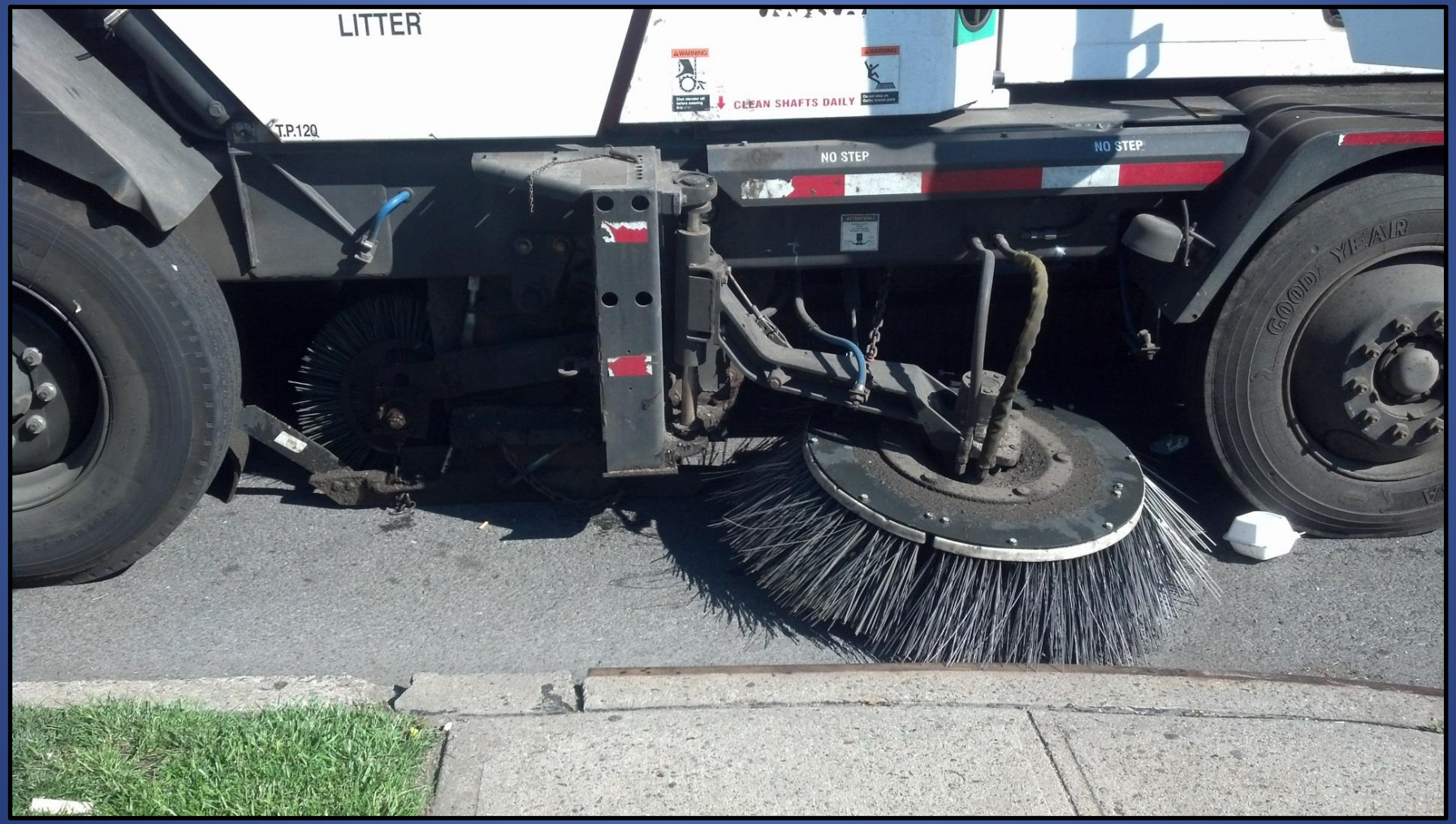
# Regenerative Air VACUUM





POROUS
TECHNOLOGIES, LLC
*When it Rains...it's Porous™*

# Gutter Broom's are Inappropriate for porous pavement and act to drive sediment into pores



# Mechanical Vacuum Sweeper

# Mechanical Vacuum Sweeper

# Maintenance

SWEEPING
"How to"

By Mark Kinter

## Sweeping Porous Pavement

Research demonstrates that vacuum sweepers are the best option when sweeping porous pavement

The use of porous pavement surfaces for parking lots, driveways, alleys, and footpaths as an effective best management practice to control stormwater runoff has been growing at a double digit rate in the United States in recent years. The long-term success of porous pavement systems to promote maximum water flow depends on proper installation, maintenance and cleaning practices – including regular sweeping with a pure vacuum sweeper.

Brian Giles, sweeper products manager at Elgin Sweeper, says Elgin has participated in various research programs with major universities and municipalities across the United States to develop a better understanding of the maintenance requirements of porous pavement.

"This research has helped clarify the role vacuum sweepers and regenerative air sweepers play in maintaining and cleaning porous pavement surfaces," Giles says.

### Types of Permeable Surfaces

There are three types of permeable surfaces in use in the United States for stormwater remediation purposes – porous asphalt, porous concrete, and interlocking paver blocks.

Porous asphalt and concrete tend to be multiple-layer construction. Water runs through the layers to a sub-layer, which allows general or directed drainage. Cleaning the pores of porous asphalt or concrete is somewhat challenging.

"When high-pressure sprayers are used for cleaning, pollution is actually driven into the pores," Giles says.

Interlocking, permeable paver blocks are non-porous blocks arranged on a porous subsurface. The blocks have a gap between them filled with loose, sandy filler which allows water to percolate through the gaps. Giles says the use of interlocking pavers is growing in the United States, especially in low-speed (under 45 mph) traffic and parking areas and in high-pedestrian areas.

### Plugging

Porous asphalt, porous concrete, and interlocking paver block surfaces can all become plugged with fine debris – mixtures of silt and oils – that can stop the percolating action and negate the purpose of the system. The first step in retaining the porous nature of the surfaces should be to install signs to inform the casual passerby that the surface is porous and that certain activities – such as depositing landscape material – should be avoided.

If pavers are routinely cleaned, the depth of plugging can generally be limited to half an inch. The most effective way to restore the percolation of paver surfaces is to remove the top layer of granular filler that is contaminated. Clean filler is then reapplied.

Several industry studies have shown that both surface types will plug, to varying degrees, with silt, fine clay, cement derivatives, and decomposed plant material. Maintaining and cleaning porous pavement surfaces to prevent the buildup of these sediments requires a different approach than the one used for traditional pavement.

### Regenerative Air Sweepers

Regenerative air sweepers are the second most common type of street sweeper in the United States. They account for about 30% of all sweepers sold. In gen-

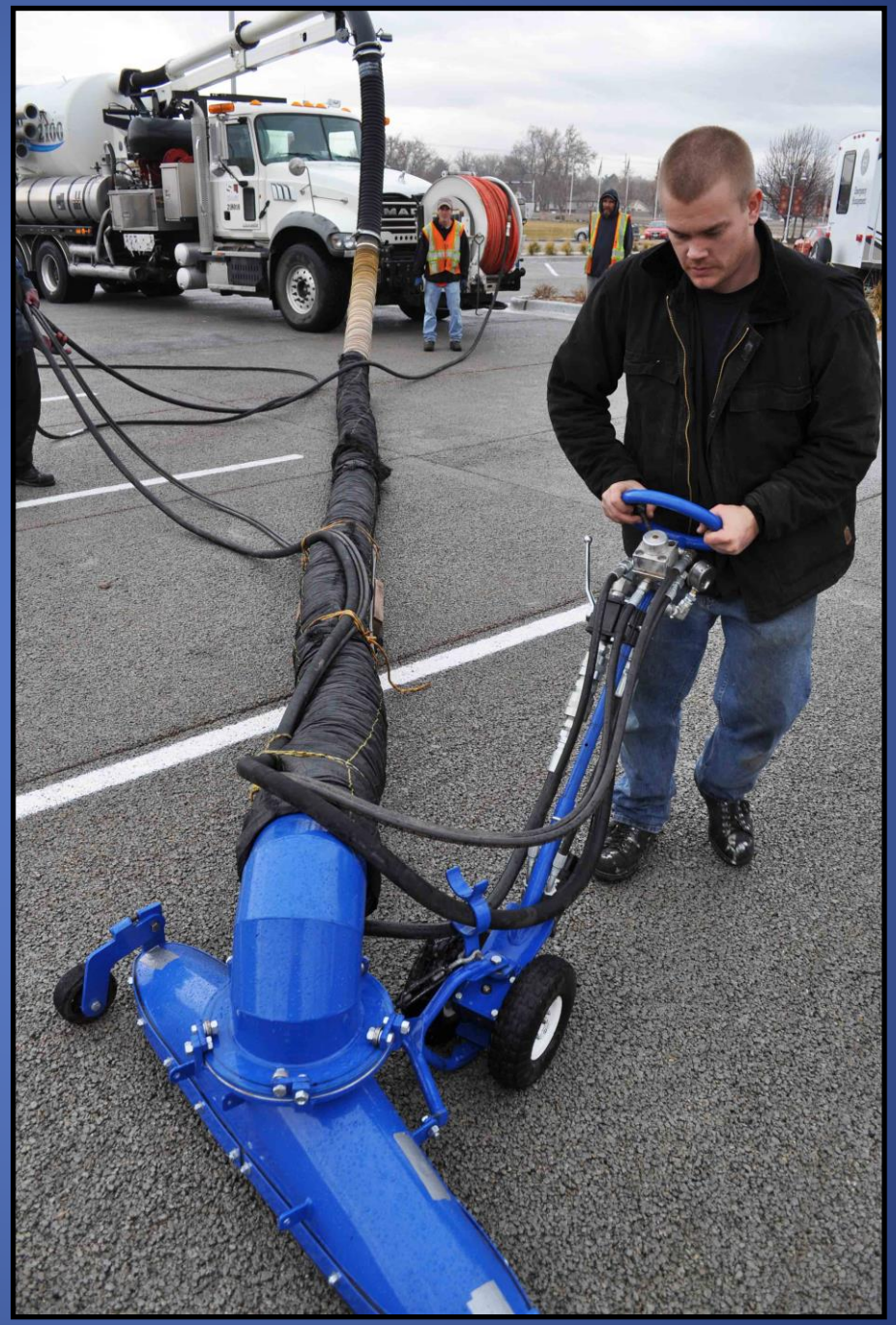


*Contractors need to understand the mechanics of street sweepers and their effects on porous surfaces before using a sweeper to clean the surface in order to prevent further clogging.*



# B.I.R.D.

## Bunyan Infiltration Restoration Device

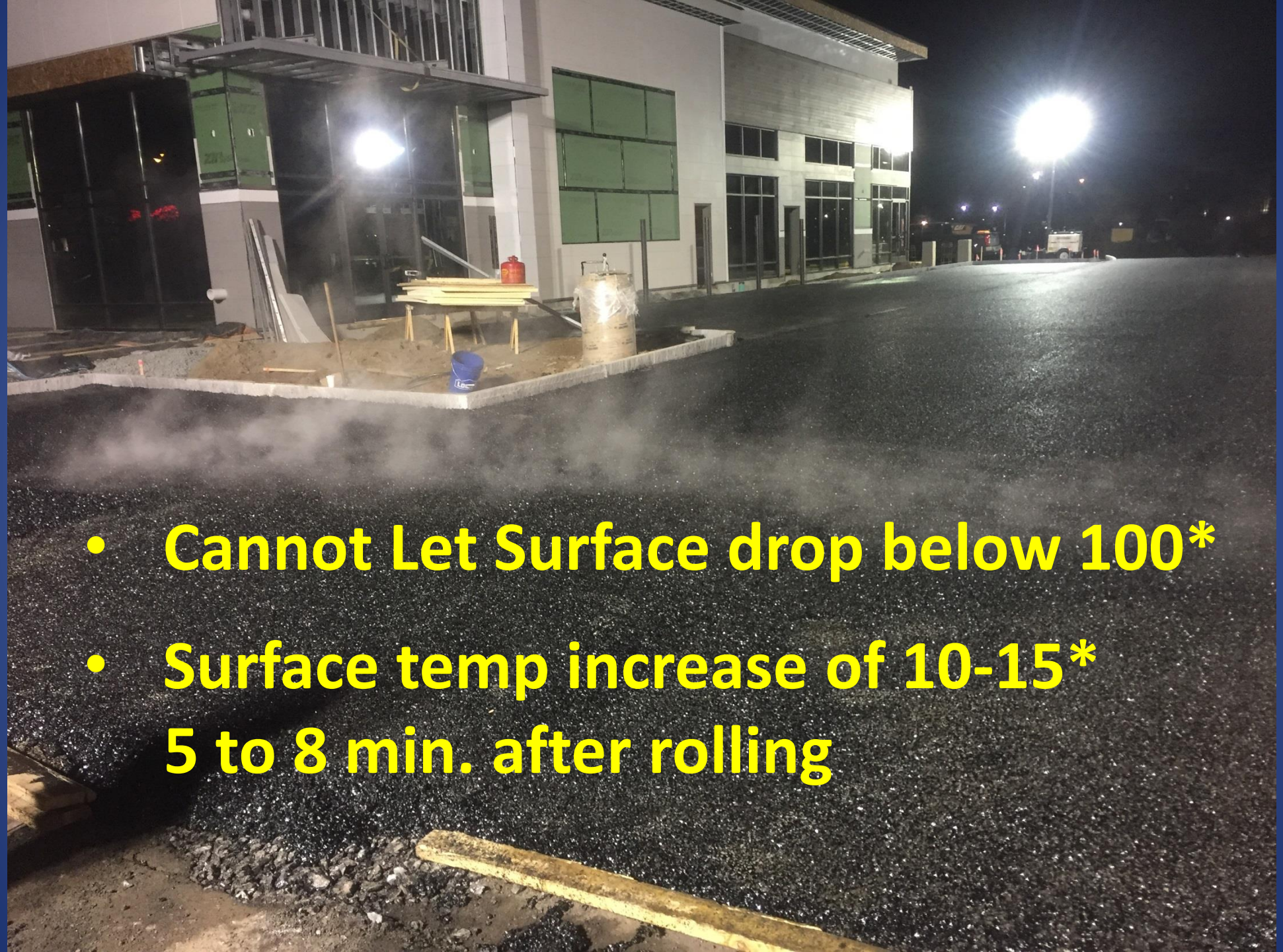


# Cold Weather Porous Paving
# Less Than 50* F

# Cold Weather Porous Paving
# Less Than 50* F.

- **Must Use Multiple Rollers (3 to 5) Operating Almost Continuously**
- **Lots of Water on-hand**
- **Must Have Internal and Surface Temps Measured**
- **Consider Warm Mix Additives**
- **Keep Haul Time Short**
- **Use Insulated Trucks, Covers**
- **Wind Is a Major Concern**
- **Waste % Goes Up, 2-4 Tons per truck**
- **Hotter Mix at Plant Not Allowed**

# Cold Weather Porous Paving


• Cannot Let Surface drop below 100*
• Surface temp increase of 10-15*
5 to 8 min. after rolling

# Cold Weather Porous Paving


- **Pave in Parallel Pulls**
- **Do Not Work Towards the Middle**

# Quality Control

## Barton & Loguidice — Porous Asphalt Paving Information Sheet

- Binder Course - 40* to 70* F. - Ambient Temp **(Must have 45* Min. Surface Temp)**
- Top Course - 50* to 80* F. **No Paving Top Course w/ Ambient or Surface under 50* F.**
- **NOTE: Paving in 50* and lower is very difficult due to rapid edge and surface cooling. Rolling operations must be continuous at 50*. At 80* and up, expect finish rolling to take place 4 to 5 hours after placement especially in sunny conditions.**
- Wind – up to 10 mph Pave @ 60* F. Up to 20 mph pave @ above 65* F.
- Preferred Maximum delivered Temps, Binder 290*F , TOP = 280*F
- Contact ENGINEER - **If Temps over 295* F.** in Truck or After exiting the Screed **Use Internal Temperature Probe if Surface Temps Are At Limit & RECORD This Temperature.** Check the Temp of Screed Often, Verify it is at or under 280*

Verify the Stone Surface (Choker Course) will not be easily displaced or "rutted" by the paver or trucks.

**NO Diesel Fuel or Kerosene to be used on equipment or in trucks**

**ROLLING → Very Slow - Only STATIC Rolling with (CLEAN) Double Steel Drums**

- Roll Binder Course – Surface Temperature - 220 to 240* F… Four (4) Passes min, 10 -12 Ton
- **Binder Course Finish Rolling -> 10 - 12 Ton – Roll 110* – 130* F. to Target Density**
- Roll Top Course - Surface Temp. = 200 - 240*F. Three (3) Passes 10-12 Ton (Must be 10-12T)
- **Top Course Must also be Rolled -> 10 – 12 Ton BETWEEN 120* - 140* F to Achieve Density**
- **Top Course Finish Rolling -> Surface Temperature - 100* - 120* F. to Target Density**
- Centerline or Cold Joint – Meet previously paved edge with Fresh Hot Asphalt. Roll to Pinch Joint when Temps Equalize or the cold side temp. stops rising. Min. Cold Side temp = 130*
- Final Cleanup Rolling may be done with 2 ton min. roller, No vibrate and 100* or more
- **At 100*F Surface Temp - Very difficult to clean up roller marks, At 90*F it is too late.**
- Plate Tampers do not provide adequate density, Use them Only in non-Vehicle Traffic Areas

**Rice Number, Project Target Density (PTD), Gauge Targets**

| Pavement Density Gauge | TOP<br>Batch Plant Only Top Course Project Target Density (PTD), lbs/ft³ | BINDER<br>DRUM Plant Binder Course Project Target Density (PTD), lbs/ft³ | BINDER<br>BATCH Plant Binder Course Project Target Density (PTD), lbs/ft³ |
|---|---|---|---|
| **Rice Number from Plant** | 2._____ | 2._____ | 2._____ |
| Model_____<br>SN_____<br>Correction Factor _____ | Target | Target | Target |
| | | | |
| Model_____<br>SN_____<br>Correction Factor _____ | Target | Target | Target |
| | | | |

These are General Guidelines, They do not address all potential conditions or situations.

B&L_REVISION_ 05/15/2019, TCB

No Tool or Rake "Scrapings" Dropped on the asphalt

Make sure the Binder Course is CLEAN before installing Top Course

Use Plywood under rubber paver tracks for tight turns Binder Course will be damaged if not used

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Project Target, Gauge Read, Densities per Meter – Note Serial Numbers

| Gauge | TOP<br>Batch Plant Only Top Course Project Target Density (PTD), lbs/ft³ | BINDER<br>DRUM Plant Binder Course Project Target Density (PTD), lbs/ft³ | BINDER<br>BATCH Plant Binder Course Project Target Density (PTD), lbs/ft³ |
|---|---|---|---|
| Troxler Model 3430<br>Serial Number 23531 | 123.5 | 122.5 | 124.1 |
| Instrotek Xplorer<br>Serial Number 720 | 122.8 | 122.0 | 123.5 |
| PQI Model 301<br>Serial Number 002792,<br>Programmed Offset Value<br>16.0 | 139.6 | 138.9 | 140.4 |

B&L_REV1_ 4/26/2013, TCB

$G_{max}$ = 2.xx for Mix (From Plant each day )

**$G_{target}$ = 2.xx – (19% x 2.xx) x 62.4 lb/cf**
**Correction Factor for Each Meter**

# PDH Questions

- A Porous Pavement systems may **NOT** be advisable when:

a. It is Adjacent to a Contaminated Soil Site
b. Road Profile or Grade is 5%
c. Used at a Fueling Station
d. Installed adjacent to a Desert
e. All of the Above

# PDH Questions

- Minimum number of Seconds of additional Dry Mixing Time Must you add to Porous Asphalt when using Fibers

a. 0
b. 5
c. 20
d. 100

# PDH Questions

- What ambient air temperature range is it recommended to place and finish Porous Asphalt?

a. 85 to 100 degrees Fahrenheit

b. 30 to 40 degrees Fahrenheit

c. 867-5309

d. 273 degrees Kelvin

e. 50 to 70 degrees Fahrenheit

# PDH Questions

- Applying a Choker Course Can help you accomplish which of the following:
  - Get Arrested
  - Seal off the Lower layers
  - Win a Cage Fight
  - Stabilize the larger stone course or courses

# PDH Questions

- True or False

  Geotextiles and other Geo-synthetics require Careful Attention to Detail for Proper Performance

# PDH Questions

- What is the maximum thickness of Choker Course that should be used in a porous asphalt design.

  a. 4”
  b. Micro-surface
  c. 2”
  d. None of the above

# PDH Questions

- True or False

- The lower the Asphalt Mix Temperature, The likelihood the project will have a higher quality Porous Asphalt.

# PDH Questions

- True or False

- Dig Deep when loading 100% Crushed, Washed Reservoir, Choker, or Stabilization Stone ?

NJAPA


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