Earthwork Design

1

Soils Report

- Types of soil present
- Topsoil thicknesses
- Marsh/Rock depths
- Existing pavement thicknesses
- EBS recommendations
- Subgrade Improvement
- Expand the Fill Factors

2

Earthwork Computations and Expand the Fill

3

Expand the Fill

Soils will undergo numerous volume changes from its insitu state to excavated to compacted in final location.

4

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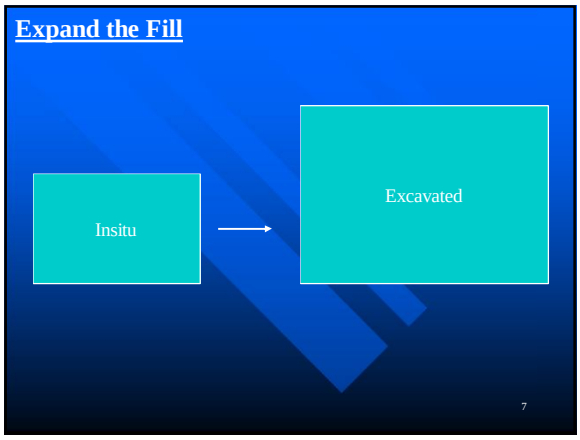
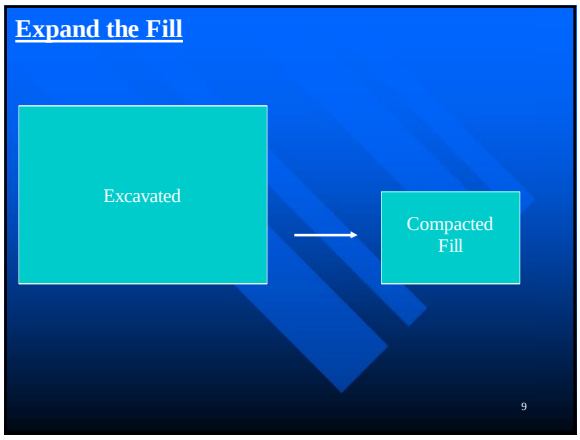
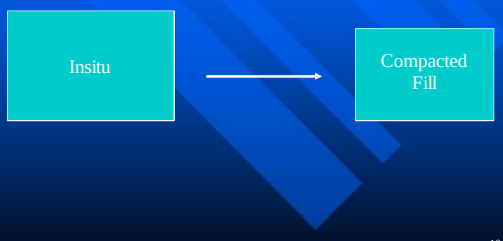
Expand the Fill



Expand the Fill



Expand the Fill



10

Expand the Fill

The expand the fill method takes into account the overall negative net volume change as the soil goes from its insitu state to its final compacted state.

Fill volumes are ultimately increased by an Expand the Fill factor to determine the amount of insitu cut soils needed.

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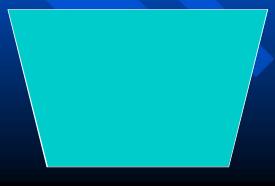
Expand the Fill (example)

Volume of fills on project = 1,000 cubic yards

Expand the Fill factor of common excavation soils = 1.2

Volume of common excavation needed = 1.2*1000 cy = 1200 cy



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Expand the Fill

- Factors provided in Soils Report
- Based primarily on soil types, insitu properties of the soil and past experience.

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Expansion Factors

Expanding the Fill

For Silts and Clays: (Example Values)

0-2 foot Cut - Expand 1.67
2-6 foot Cut - Expand 1.33
6+ foot Cut - Expand 1.18

For Sands: (Example Values)

0-2 foot Cut - Expand 1.25
2-6 foot Cut - Expand 1.18
6+ foot Cut - Expand 1.11

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Expansion Factors

For Marsh:

Expand 2.0

For Rock: (Greater Fill Quantity After Blasting)

Sandstone – Expand 10%
Limestone – Expand 20%
Granite – Expand 30%

Fill Expansion Factor: Will Be <1.0 in Fill (.90?)

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Expansion Factors

Many times an Expansion Factor Will be Provided in the Soils Report. Usually This Factor is between 1.1 – 1.5

Be Aware:

- If Your Project is Mostly Skim/Shallow Grading the Factor is Higher
- If Your Project Contains Large Cuts and Borrow Quantities the Factor is Lower
- Usually Not a Big Deal (Quantity Changer) Unless the Project Has Over 100,000 Cubic Yards.

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Types of Excavation (Bid Items)

1. Common Excavation
2. Rock Excavation
3. Stone Piles and Stone Fences
4. Marsh Excavation

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Common Excavation

Std. Spec. 205.2.2: Common Excavation

(1) Under the Excavation Common bid item, excavate all materials not classified as rock, stone piles and stone fences, or marsh excavation. For contracts without the Excavation Rock bid item, remove boulders having volumes of one cubic yard or more under the Excavation Common bid item.

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Rock Excavation

1. Bid Item 205.0200
2. Rock Excavation Includes Bedrock, Boulders Greater than 1 Cubic Yard and Material so Cemented That it Acts Like Rock
3. Bedrock Depth May Influence Right of Way
4. Can it be Used for Subgrade Improvement or Base Course? Tests May Be Provided/Required. Requiring Its Use Will Require a Special Bid Item

20

Rock Excavation

Std. Spec. 205.2.3: Rock Excavation

(1) Under the Excavation Rock bid item, excavate hard, solid rock in ledges, bedded deposits, and unstratified masses, and all conglomerate deposits or any other material so firmly cemented they present all the characteristics of solid rock, and the engineer determines it is impracticable to excavate this material without blasting or using rippers. Rock excavation also includes removing all rock boulders having a volume of one cubic yard or more.

(2) The classification of rock excavation does not apply to crushed aggregate or asphaltic base or surface courses, or to concrete base or surface courses.

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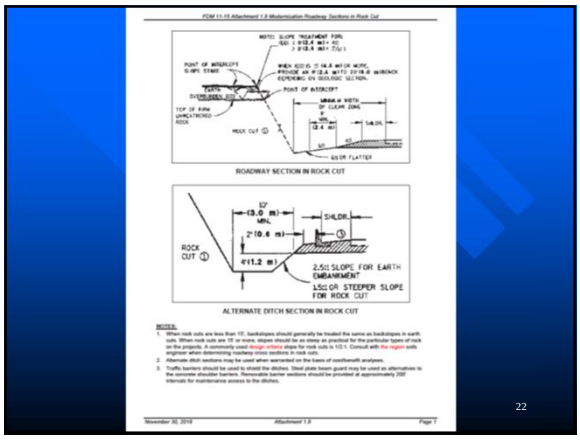

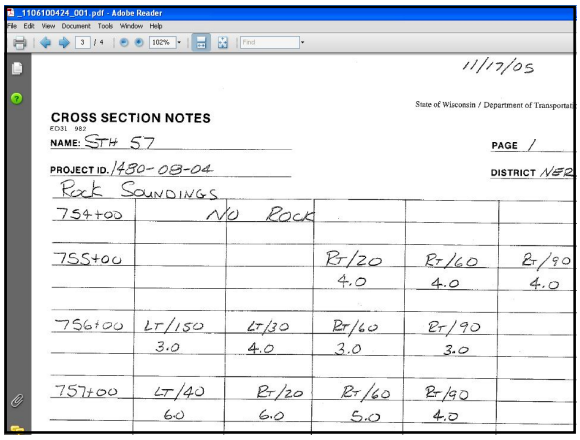

Rock Excavation

- Can it be Used for Base Course, Breaker Run or Subgrade Improvement? Tests May Be Required
- Quality Tests on Rock Excavation Included in the Special Provisions May Lower Bid Prices for Crushed Base Course, Breaker Run or Subgrade Improvement
- Example: If You Are Confident the Rock Meets Soundness and Wear Requirements, May Want to Reduce/Wave the Requirement to Perform These Tests in the Special Provisions

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Marsh Excavation

1. Bid Item 205.0400
2. Is it Marsh or Just Thick Topsoil?
3. Can it be Used Outside the 1:1 Slope?

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Marsh Excavation

Std. Spec. 205.2.5: Marsh Excavation

(1) Under the Excavation Marsh bid item, perform required excavation below the original ground level of marshes and swamps underlying proposed embankments, within the limits indicated on the plans or as the engineer determines, and necessary or desirable to ensure a stable foundation for embankment or to accelerate the subsidence of unstable material under embankment load. If old road embankment cores are encountered in areas involving marsh excavation, salvage the portions of old road cores as designated on the plans and use them in the construction of embankments. This bid item also includes all material of whatever nature encountered below the original ground elevations in areas designated for this work, exclusive of portions of old road cores designated for salvage and used in construction of embankments.

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CROSS SECTION NOTES

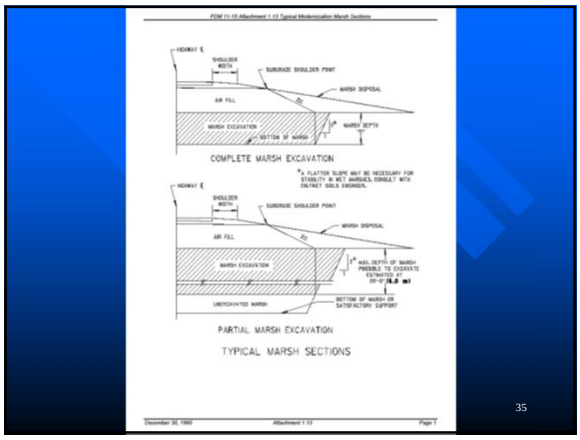
ED31 982

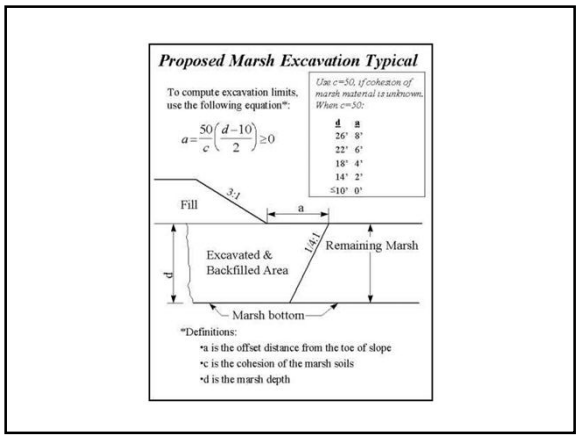
NAME: STH 57 MAINLINE PAGE 1-1

PROJECT ID. 1480-08-04 DISTRICT NER

MARSH SOUNDINGS

657+80	NO MARSH			
658+00			RT/20 0.0	RT/90 2.0
658+40	LT/90 0.0	LT/20 2.0	RT/40 2.0	RT/90 2.0
659+00	LT/125 0.0	LT/80 2.0	LT/60 2.0	LT/30 0.0
659+20	NO MARSH			





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Marsh Excavation or Thick Topsoil?

1. Method of Removal
2. Thick Topsoil (Dozer)
3. Marsh (Backhoe or Dragline)

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Reuse of Marsh Excavation

- Can it be Used Outside the 1:1 Slope?
  Answer: It depends
- Will Marsh Disposal Affect Future Widening?
- Is it So Wet That it Will Slide or Slough?
- Are Signs, Utilities or Other Structures in the Deposal Area?

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Select Borrow

1. Bid Item 208.1100

2. Need to Specify What Material is Required
   a. Granular Backfill
   b. Specific Structure Backfill
   c. Impermeable Clay
   d. Other

40

Select Borrow

1. Onsite material will need to be tested to determine if suitable for use as Select Borrow.

2. Specify where material is located and where it will be placed

3. Will save money if present onsite versus importing to project.

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Onsite Select Borrow

Example Special Provisions:

Use Granular Material Excavated from Station 126+00 to Station 134+00 to Backfill the Marsh Excavated From Station 107+00 to Station 113+00. The Contractor is Not Responsible for the Gradation of This Material.

42

Select Borrow Present on Project For Pond Clay Liner

- Within the Special Provisions
- Material Meeting the Specifications of Clay Liner is Located Where the Pond is to Be Constructed
- May Still Require Testing to Comply With DNR Specifications

43

Excavation Below Subgrade EBS

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Predicting EBS Areas

- Groundwater Levels = 3 Feet or Less
- "B" Horizon Soils
- Topsoil Depths Exceed 12 Inches
- Moisture Levels Above Plastic Limit
- Depositional Characteristics

45

Predicting EBS Areas

- Roadway Constructed Prior to 1940
- Extensive Filling
- Existing Roadway is Distressed
- Highly Variable Soil Conditions Exist
- Subgrade is Within 2 Feet of Original Ground Surface

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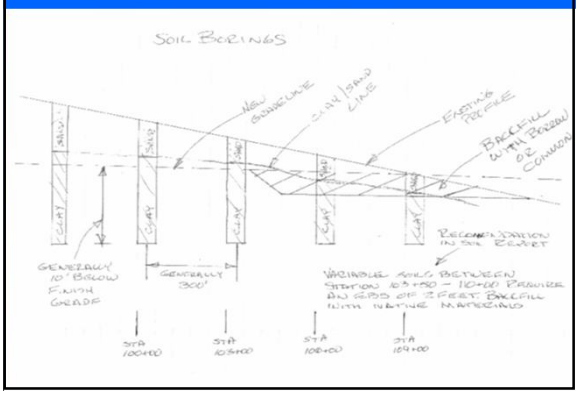
Excavation Below Subgrade (EBS)



Excavation Below Subgrade (EBS)

- Bid as Common Excavation
- Bid Item 205.0100

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Excavation Below Subgrade (EBS)

- Depth and Lateral extent
- Don't Cut Short or Lessen the Depth Without Checking With the Soils Engineer
- EBS the Entire Cut Below Any Pavement Structure Including Paved Shoulders

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Excavation Below Subgrade (EBS)

What to Backfill the Excavation With?
- Borrow or Common?
- Granular Material or Breaker Run?

Is Drainage Required? Tile or French Drain?

50

Excavation Below Subgrade (EBS)

Can Geosynthetics Reduce the Depth of EBS?
Generally Yes

A SAS (Subgrade and Aggregate Separation) Geotextile Can Reduce the Backfill About 6"

Generally, Never Less Than 1 Foot EBS

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Excavation Below Subgrade (EBS)

Using EBS as fill outside the 1:1 slopes

- Treated similar to marsh excavation.
- If Too Wet, Be Aware of Slopes, Signs and Other Structures Placed Outside the 1:1

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Frost Heaves/EBS Transition

1. Created When Frost Susceptible Soils Abut Non-Frost Susceptible Soils
2. Transition to Normal Grading @ 20:1 (?)
3. Where to End the EBS Edge?

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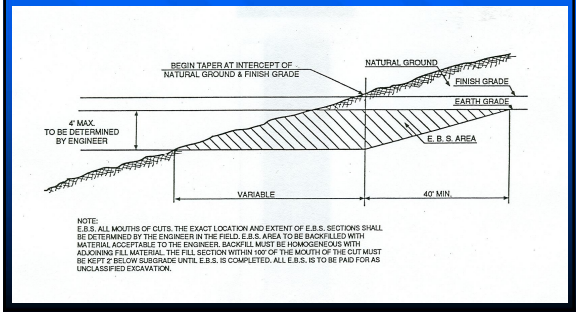
Transition Detail



Excess Salvaged Topsoil

1. Bid Item 625.0500
2. If More Topsoil is Stripped Than Required to Be Placed, it is Paid For as EBS
3. Can it Be Used Outside the 1:1 Slope?

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Pavement Design Parameters

Design Group Index (DGI), Soil Support Value (SSV) and Resilient Modulus (Mr)

- Soils Report should provide these values
- Typical Values Can Be Found in the WisDOT Geotechnical Manual
- General Soil Parameters for Pavement Design Can be Found in FDM Section 14-1
- In the Future, a Soils Resilient Modulus (M_r) May Be Used/Required to Design the Pavement Structure

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Select Materials in Subgrades FDM 11-5-15 (Subgrade Improvement)

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Subgrade Improvement

From FDM 11-5-15: Use in the Upper Portions of Subgrades That Are Difficult for Subgrade Construction. These Include:

- All Silty Soils
- Most Silty Clay Soils
- Soft Clay Soils
- Mineral Soils With a High Organic Contact
- Any Other Soil With a History of Problems

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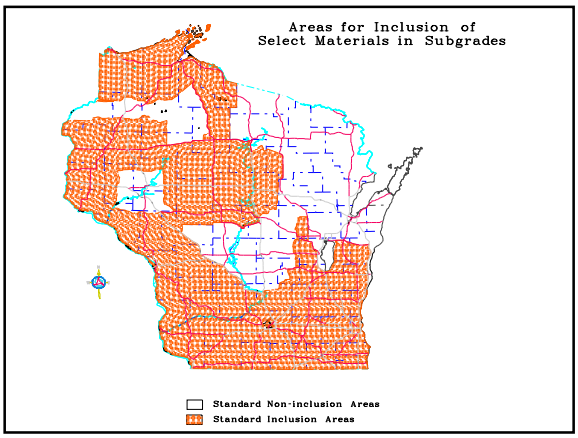

Subgrade Improvement Typicals

Ten Standard Typical Cross-Sections Shown In FDM

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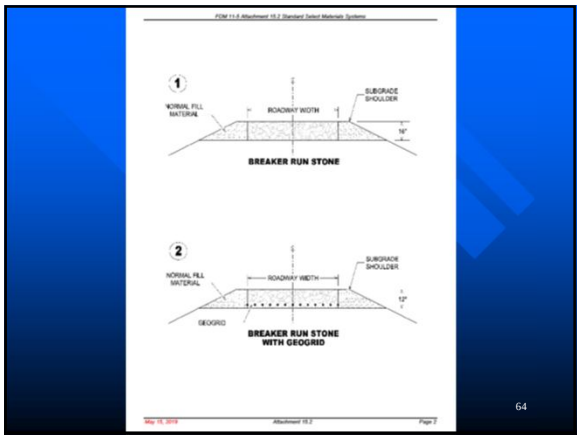

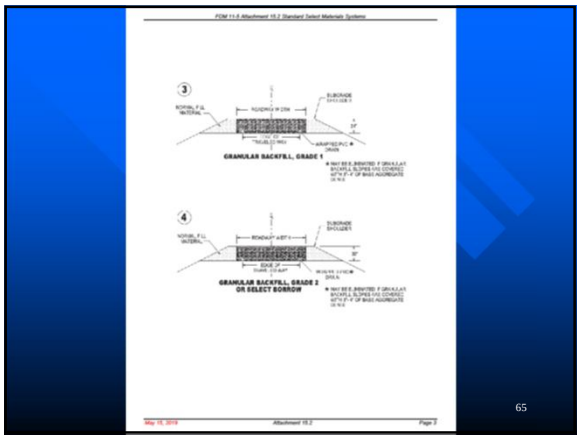

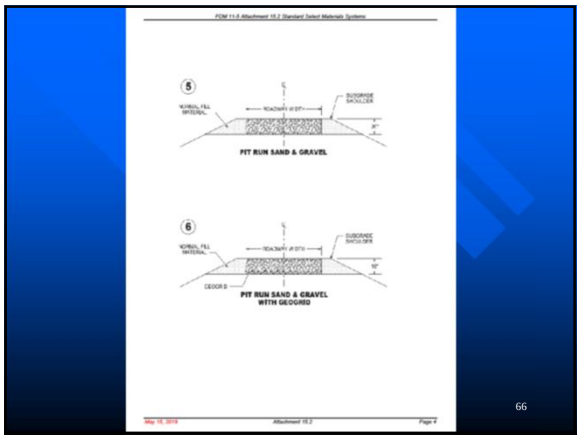

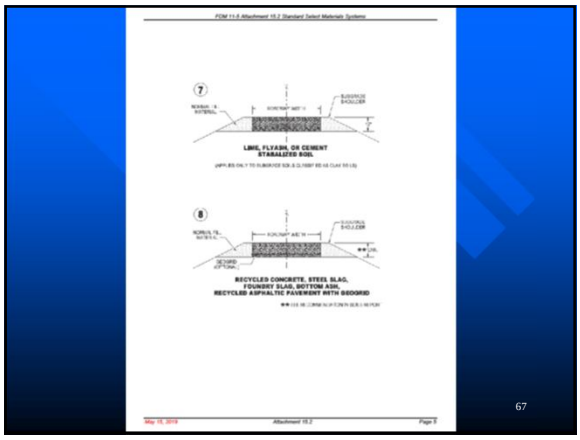

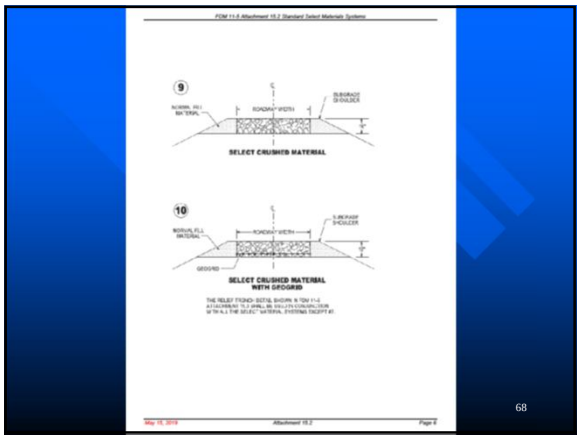

Subgrade Improvement

Choosing the right one to use

- Whatever typical is chosen, borrow and excavation quantities will be influenced.
- Geogrid will produce less waste. Will also limit the depth of excavation needed in areas where utilities may be in the way.
- Nearby sources of material. Gravel pits or rock quarries?
- Can contractor crush old pavement as a waste product to use? Can be processed to meet requirements of Breaker Run or Select Crushed.

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Estimated Cost of Select Material

FDM Table 15.1:

Select Material System	Estimated Cost/Lane Mile
1-Breaker Run Stone	$125,000
2-Breaker Run Stone w/Geogrid	$130,000
3-Grade 1 Granular Backfill	$105,000
4-Grade 2 Granular Backfill	$100,000
5-Pit Run Sand & Gravel	$100,000
6-Pit Run Sand & Gravel w/Geogrid	$115,000
7-Flyash, Lime, Cement Stabilization	$ 95,000
8-Salvaged Materials or Byproducts	Highly Variable
9-Select Crushed Material	$140,000
10-Select Crushed w/Geogrid	$140,000

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Subgrade Improvement and the Pavement Design

- Soil Report Will Provide Soil Parameters for Pavement Design

FDM 14-5-5: Regardless of the Material Used to Improve the Subgrade, it is Still Considered Subgrade and Should Be Given no additional credit in the structural design process beyond what is stated in (the FDM).

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Subgrade Improvement and the Pavement Design

Table 1.1 Soil Parameters for Pavement Design

Material	AASHTO	Soil Support Value	Wisconsin Design Group Index	Subgrade K
I – well sorted	A-1-a	5.5-5.4	0-2	300
	A-1-b	5.3-5.2	3-4	275
	A3	5.1-5.0	5-6	250
	A-2-4	4.9-4.7	7-8	225
	A-2-4/A-4	4.6-4.5	9-10	200
	A-4/A-6	4.4-4.2	11-12	175
II – poorly sorted	A-4	4.2	12	150
	A-4/A-6	4.1-3.8	13-15	125
	A-7-6	3.7-3.5	16-17	100
	A-7-5	3.3-3.0	18-20	75

Design Group Index as it relates to Frost Index

0-1	F-0 to F-1
1-6	F-2
6-15	F-3
15-20	F-4

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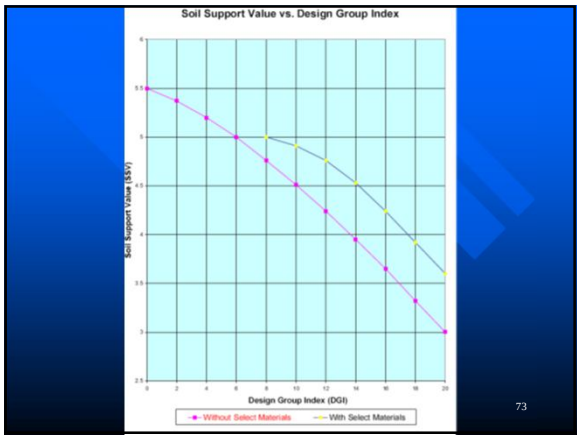

Earthwork Design – Review

- The Soils Report Provides Information About Existing Soils and Borrow?
- Excavation Below Subgrade Requires a Special Bid Item?
- Marsh Excavation Must Be Disposed of Off the Project Site?
- Subgrade Improvement is Required on All Major Grading Projects in the State?

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