Earthwork Construction

1

Inspector's Responsibility

1. Specifications
   Read and Understand Pertaining Standard Specifications and Special Provisions – (Don't forget Chapter 1)
2. Communication
   - Talk to the Contractor and Project Engineer
   - Speak up - Saying Nothing May Imply Concurrence
3. Documentation
   - Document Contractor Operations
   - Check grades
   - Measure quantities
   - Document Discussions and Resolutions

2

Proper Embankment Construction

1. Proper Preparation of the Foundation
2. Use of Suitable Materials
3. Placing Layers

3

Clearing and Grubbing

4

5

6

Section 201 - Clearing and Grubbing

Cutting, removing and disposing of:

- Trees
- Brush
- Windfalls
- Logs
- Vegetation
- Roots
- Stumps
- Stubs
- Timber

7

Clearing and Grubbing

Std. Spec. 201.3: Construction

(1) Clear and grub all areas within the clearing and grubbing limits defined as follows:

1. Between lines 5 feet outside the grading limits of roadway cuts and fills, including intercepting embankments, channels, ditches, borrow pits, and marsh or waste disposal areas.
2. Other parts of the right of way the plans or special provisions designate.
3. Designated clear zone and clear vision areas.
4. With the engineer's approval, areas with vegetation that interfere with excavation, embankment, marsh, or waste disposal.

8

Clearing and Grubbing

Section 201.3 (1):

5. The contractor does not have to grub the following:
   - Areas designated for occupation by earth embankments 6 feet or more in height.
   - Areas used for marsh excavation disposal for which the state has obtained easements.

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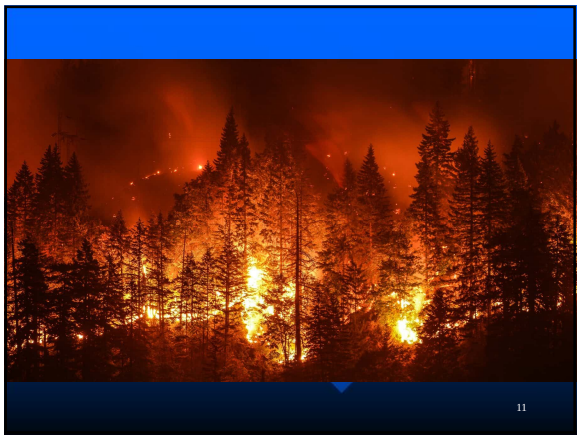

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Clearing and Grubbing

- Be Careful With Burning
  - o Don't create a nuisance
  - o Don't damage public or private property
  - o Get necessary permits and comply with WDNR rule NR429.

12

Clearing and Grubbing

- Can Contractor Bury Material?
  If burning is not allowed and the engineer approves then bury material in engineer approved locations within the right-of-way that are outside of the construction limits.

13

Removals

14

Removal Items

Std. Spec. Section 204: Structure Removal

- Remove Entirely or Break Down Structures as Follows:
  - Within the roadbed, to a depth of at least 2 feet below the subgrade
  - Outside the roadbed, to a depth at least 2 feet below the finished grade
  - At any location to the extent to avoid interfering with the work.
- Backfill
  Suitable soil, broken masonry, granular backfill.

15

Pavement Removal

Section 205 - Completely remove existing pavement to a depth of 2 feet below the finished grade line or as shown on plans.

16

Tanks or other Special Disposal

1. Usually Covered in the Special Provisions
2. Something Unexpected, Bones, Landfill
3. What Do I Do?
   - Stop Work in the Area
   - Contact Environmental Staff and Management

17

Disposal on or off the Right of Way

1. Don't Bury Anything That Could Pollute Ground Water
2. Be Aware of Possible Future Construction
3. Will Disposal Area Become Excess Property?
4. Is Material Being Disposed of in a Wet Land?
5. If Disposing Off Site, Property Owner Contact?

18

Topsoil Removal/Salvage

19

Topsoil

- Remove topsoil from the roadway foundation area per Section 205.
- Salvage topsoil under Section 625 necessary to cover completed slopes.
- Remove excess, unstable topsoil as EBS and dispose or reuse as allowed.

20

Organic or Mineral Topsoil

1. Organic is Usually 10-50% Humus or Organic
2. Mineral Topsoil May Be as Little as 5% Organic and May Be a Suitable to be Incorporated into Embankment Construction.
3. To Find Out Composition, Loss on Ignition test to Burn Off Organics

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205 Roadway and Drainage Excavation

Types of Excavations (Bid Items)

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

24

Common Excavation

- Anything that isn't classified as Rock, Stone Piles and Fences or Marsh.
- Payment is full compensation for work specified with no separate contract bid items for hauling, forming, compacting, shaping, sloping, trimming, finishing, maintaining embankments, and other incidental work.
- Needs to be measured in the field.

25

Minor Excavation Common

1. Section 205 - The Engineer May Elect to Measure Excavation Common by the Cubic Yard in the Vehicle
2. Have an Agreement With the Contractor
3. Inspectors need to make sure trucks are being filled consistently.

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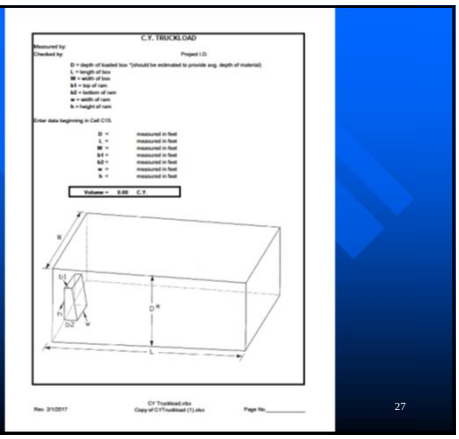

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Minor Excavation Common

- Using weight – volume relationships.
- Consult Regional Soils Engineer.
- Utilize typical published values as guidance.
- Come to an Agreement with the Contractor on Truck Volume
- If Possible, Weigh & Measure a Few Trucks

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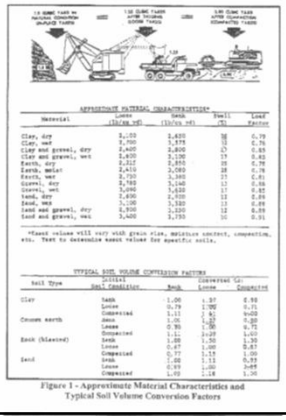

Figure 1 - Approximate Material Characteristics and Typical Soil Volume Conversion Factors

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205 Roadway and Drainage Excavation

1. 205.2.2(1) For Contracts Without the Excavation Rock Bid Item, Remove Boulders Having Volumes of one Cubic Yard or More Under the Excavation Common Bid Item
2. Keep Track If Many Boulders Are Encountered, There May Be a Claim

30

205.2.3 (1) Rock Excavation

Under the Excavation Rock bid item, excavate hard, solid rock in ledges, bedded deposits, and unstratified masses…

31

32

33

205.2.3 Rock Excavation

1. Needs to be measured and paid for.
2. Does the Plan Rock Line Correspond to the Field?
2. Survey the Field Rock Line

34

Cemented Materials

Section 205.2.3 (1) … and conglomerate deposits of any other material so firmly cemented they present all characteristics of solid rock, and the engineer determines it is impracticable to excavate this material without blasting or using rippers...

35

Standard Specification Section 205

1. Sometimes a judgement call on where soil ends and rock begins. Examples include dense till soils and weathered bedrock.
2. Over-excavate rock 6 inches below subgrade.

36

Bedrock Issues/Concerns

If plan rock slopes cannot be held. Need to field adjust immediately so correct toe location is achieved.

If blasting, then there may be vibration concerns with nearby facilities.

Contact:

Dan Reid
WisDOT Geologist
Central Office Geotech Section
608-246-7946

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Boulders

Section 205.2.3 (1) … Rock excavation also includes removing rock boulders having a volume of one cubic yard or more.

- Must Measure Each Boulder in the Field
- Soils Report may contain an estimate of boulders based on test borings or geophysical methods.

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Placing Rock

1. No End Dumping
2. Must be Bulldozed or Shoved Into Position
3. When Placing Rock All Nested Voids Must Be Filled With Finer Material

40

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Rock Placement

Not Within 8" of Final Grade
Not in the Way of Beam Guard or Signs

42

Stone Piles and Stone Fences

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44

Section 205 - Stone Piles and Stone Fences

- Remove and dispose of stones, boulders, and rock fragments found assembled on the right of way in piles so that the engineer can make collective measurements by volume of the weight.
- Do not classify stones in groups or piles of less than one cubic yard in volume under stone piles and stone fences.

45

Stone Piles & Fences Disposal

Marsh Excavation

1. Marsh is Usually 50% or More Water, With a Large Percentage of Organics
2. Deep Topsoil, Generally More Than 1-Foot Deep. Usually pay as EBS
3. Marsh excavation needs to be measured in the field.

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Types or Methods of Excavation

1. Usually Topsoil if it Can Be Bulldozed
2. Marsh is Typically Excavated by Backhoe or Dragline
3. Deep Marsh May Be Removed by Special Means

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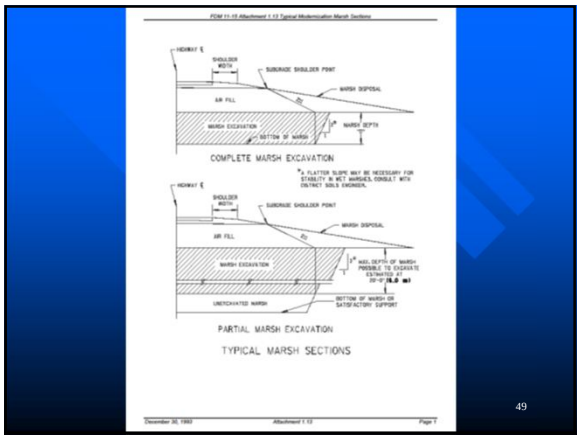

Marsh Excavation

Marsh Measurement

- Survey Crew measurements and volumes calculated using the end area method.
- For marsh excavations that can't properly be surveyed then test borings may be used to determine depth of marsh excavation.

53

Reuse/Disposal of Marsh Excavation

1. Can it be Used Outside the 1:1 Slope?
2. If Disposed Outside the 1:1 Slope:
   - Will it slide?
   - Will it be in the way of future construction?
   - Are there a signs or utilities that are affected?
3. Is it Being Properly Disposed of Off Site?

54

Backfilling Marsh

1. Select Borrow or Granular Required?
2. Using Select Material Found on the Project
3. Section 207.3.3: Placing in Marsh
   - Start on one end
   - End dump and push backfill ahead
   - Don't trap marsh in the backfill
   - Excavate full width

55

Scraper End Dumping

61

62

Embankment Construction

63

Proper Embankment Construction

1. Proper Preparation of the Foundation
2. Use of Suitable Materials
3. Placing Layers

64

Preparing Roadway Foundation

Section 205.3.2

After necessary clearing and grubbing and removal operations the disturbed subgrade needs to be compacted.

65

66

Preparing Roadway Foundation

Section 207.3.1

- Do not place embankment on frozen subgrade.
- Discontinue constructing embankments if weather conditions prevail that cause substantial freezing of fill soils during placement, unless using granular soils free of silt and clay.

67

Proper Embankment Construction

207.2 Materials:

- Fill material must be free of stumps, brush or other perishable material.
- Frozen soils should not be placed in embankments.
- Excess topsoil or other unsuitable soil may be used outside of the roadway foundation with the engineers approval.

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Proper Embankment Construction

207.2 Materials:

- In top 8 inches of fill, use materials free from large stone, rock, and broken concrete.
- Do not use material greater than 3 inches in size where boreholes or piling is to be driven.

69

Proper Embankment Construction

207.3.2 Placing Layers

- Construct embankments starting at the lowest point of the fill.
- Construct embankments in layers by spreading and leveling the material during placement.
- Spread individual layers evenly to uniform thickness throughout and approximately parallel with the finished grade for the full width of the embankment
- Place the material in layers generally no thicker than 8 inches loosely placed.

70

Proper Embankment Construction

207.3.2 Placing Layers

- Over soft soils fill can be placed in a single layer, just thick enough to support the hauling equipment while placing subsequent layers.
- If placing embankment on side slopes greater than 10 feet high and steeper than a 3:1 slope, provide vertically faced horizontal steps or benches in the existing slope to support the embankment.

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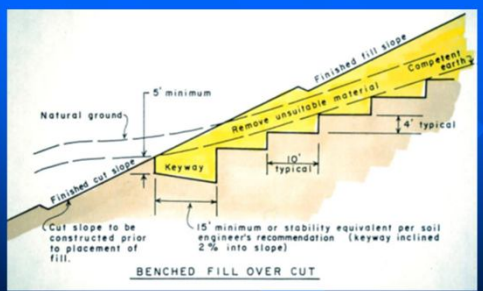

BENCHED FILL OVER CUT

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Embankment Construction

Dumping and Leveling

Compaction

Compaction

Densification of soils by the removal of air, which requires mechanical energy.

Principles of Compaction

1. Decrease Future Settlement/Consolidation
2. Increase Shear Strength
3. Decrease Permeability
4. Increase Stability

80

Section 207 - Standard Compaction

- Compact each layer of the embankment until the compaction equipment achieves no further significant consolidation.
- Provide the required compaction for each layer before placing any material for a succeeding layer.
- Visual acceptance

81

Section 207 - Standard Compaction

- Primarily using hauling and leveling equipment to achieve compaction
- The engineer may require specialized compaction equipment to provide additional compaction if, in the engineer's opinion, adequate compaction is not achieved without it.

82

83

84

Compaction Equipment

Soil Type	Equipment Type						
	Pneumatic Tired Vehicles				Smooth Drum Vibratory Roller	Padfoot Vibratory Roller	Padfoot or Sheepsfoot Static Roller
	Rubber-Tired Dozers	Off-Road Trucks	End Loaders	Scrapers			
Sand	Very Good	Very Good	Very Good	Very Good	Very Good	Fair	N/A
Sand & Gravel	Very Good	Very Good	Very Good	Very Good	Very Good	Fair	N/A
Silty Sand & Gravel	Very Good	Very Good	Very Good	Very Good	Good	Fair	Poor
Clayey Sand & Gravel	Good	Good	Good	Good	Fair	Good	Good
Silt	Good	Good	Good	Good	Fair	Very Good	Very Good
Clay	Good	Good	Good	Good	Poor	Excellent	Excellent

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Tamping Padfoot Vibratory Roller

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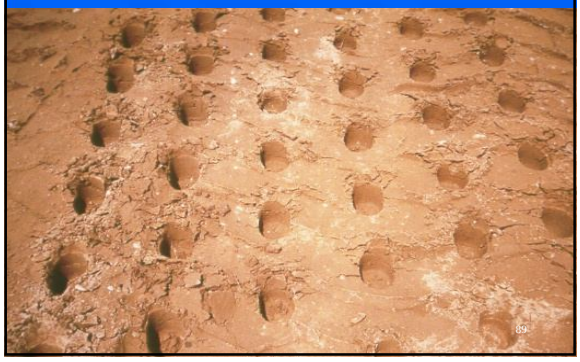
87

Sheep Foot Roller Imprint



Sheep Foot Roller Imprint

Sheep Foot Roller Imprint

91

Rubber Tire Dozer

92

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Drainage During Construction

Section 205

- During construction keep the excavation areas and embankments sloped to the approximate section of the ultimate earth grade.
- Maintain roadway, ditches, and channels in a well-drained condition at all times
- If it is necessary in the prosecution of the work to interrupt existing surface drainage, sewers, or under drainage, provide temporary drainage until completing permanent drainage work.
- WisDOT shouldn't pay for subgrade problems caused by contractor inattention.

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Embankment Construction

97

Embankment Construction

- Frequently spot check grades and cross slopes. Particularly in super elevated sections.
- Correct all grade issues prior to paving to avoid having to use expensive HMA item to correct problems.

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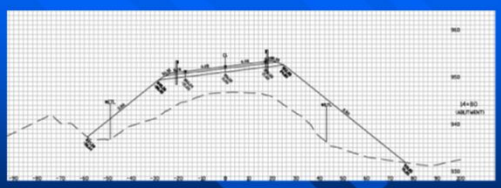

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Moisture Control

101

Moisture Control

Proper moisture conditions are essential for the efficient and proper compaction of earth embankments.

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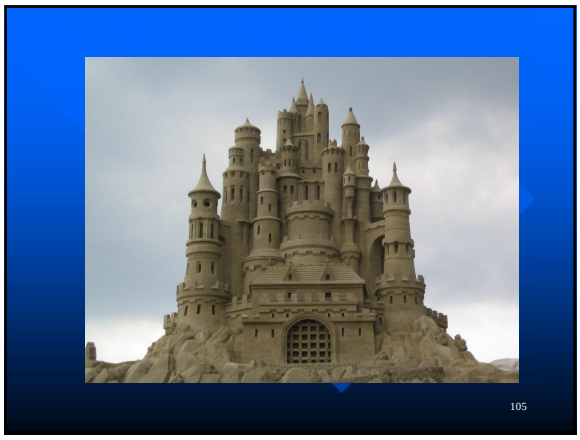

Moisture Control

207.3.6.1: General

(2) Do not compact embankment material if the moisture content causes excessive rutting by the hauling equipment, or excessive displacement or distortion under the compacting equipment. If these conditions exist, allow the materials to dry before compacting. If necessary, accelerate drying the materials by aerating or by using blade graders, harrows, discs, or other appropriate equipment to manipulate the material.

(3) If the embankment material does not contain sufficient moisture to compact properly, add water in quantities the engineer deems necessary to aid, accelerate, and secure effective compaction.

106

Disc Drying

107

Disc Drying

108

Adding Water

109

Compaction Outside the 1:1

Section 207 - Compact embankments, outside the roadway foundation, to the degree contemplated for standard compaction. The engineer may allow less compaction outside the roadway foundation if the contractor uses unstable soil.

110

Compaction in Cuts

207.3.6.4: Subgrade Compaction in Cuts

(1) Compact the finished earth subgrade in cut sections for a width equal to the width of the proposed pavement plus shoulders as specified for standard compaction...

111

Special Compaction/QMP Subgrade

112

Special Compaction or QMP Subgrade

1. Section 207.3.6.3 Special Compaction
   - Compaction Testing is Conducted
   - DOT responsible for all the testing
   - Not Used Much
2. QMP (Quality Management Program) Subgrade
   - QC/QV Spec
   - Compaction Testing is Conducted
   - Contractor Testing Used for Acceptance
   - DOT Verification Testing frequency is about 1 in 10 Contractor Tests.

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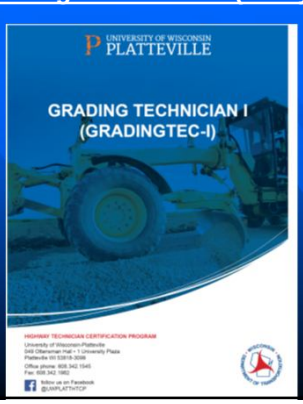
HTCP – Grading Technician I (4 Day Course)



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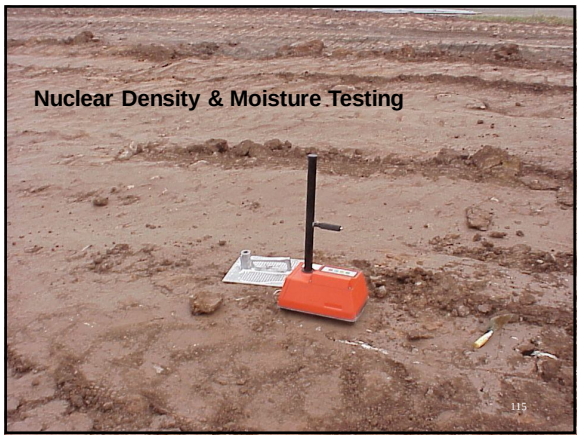

Nuclear Density Gauges

- Gauges Are Calibrated to a Certain Known Block
- Moisture Reading Should Be Verified With an Oven Dry Back
- A Nuclear Gauge Takes 2 Readings, Total Density and Moisture
- If the Moisture is Not Reading Correctly, the Density is Also Not Correct
- Need to Meet Federal Nuclear Regulations

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Excavation Below Subgrade (EBS)

117

Excavation Below Subgrade

- Remove deposits of unstable soils or other undesirable foundation material to the depth below finished grade as the plans show or the engineer directs.
- If possible, slope and drain the excavation bottoms to prevent water accumulation.
- Paid for as common excavation.
- Must be measured in the field.

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EBS - Responsibility

- WisDOT - Cut sections or shallow fills of less than 2 feet.
- Contractor – Fills greater than 2 feet.
- Contractor is responsible for stable fill or cut areas that subsequently become unstable due to improper subgrade care by the contractor.

119

Proof Rolling

1. Part of the Contract
3. Different Soils, Different Rutting
4. How Much Rutting is Too Much?
5. Difference Between Concrete or Asphalt Pavement
6. Difference if Subgrade Improvement Used

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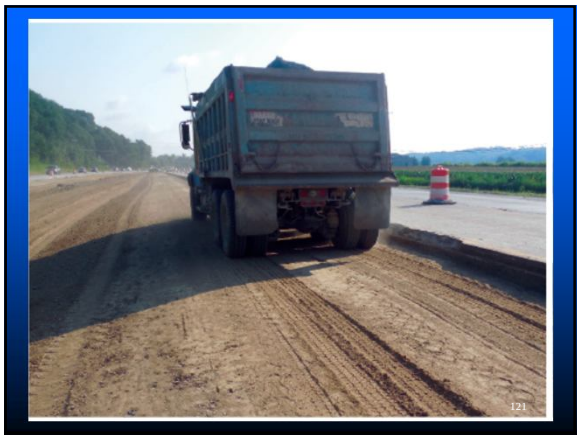
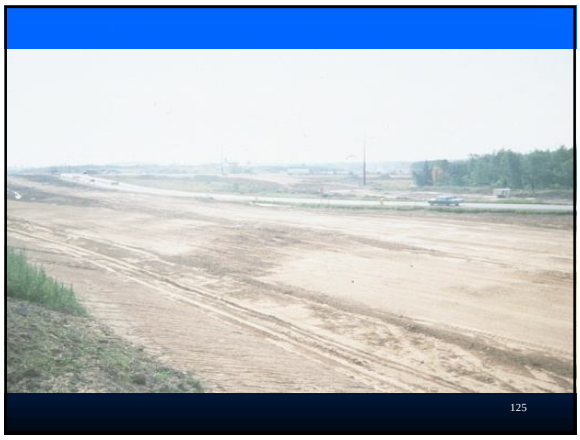
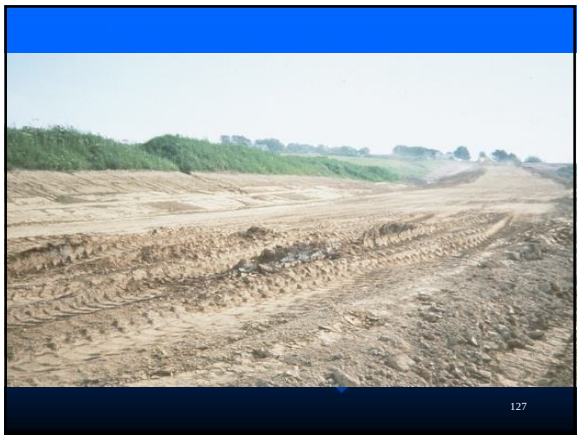






EBS in Process

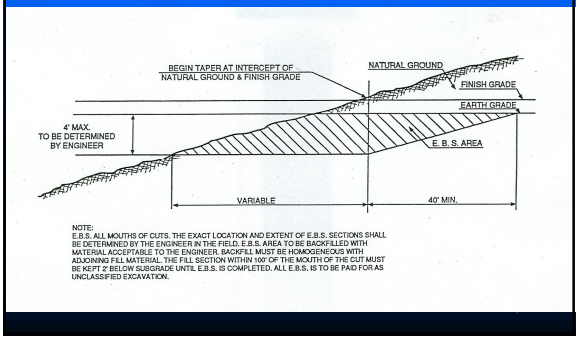
Loading Unstable Material
Can it be Used Somewhere Else?

Survey Crew Determining Volume

EBS

Backfilling EBS
With What Material?

Detail of EBS



Typical EBS Depths and Backfill

- Site specific
- Bridge deeper unstable soils rather than chase poor soils to an excessive depth.
- Cheapest to backfill with common excavation or borrow.
- Sand and gravel backfill soils can be used to bridge deeper unstable soils.
- Breaker Run
- Consult with Regional Soils Engineer

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Accepting The Subgrade

1. Can be done over the course of the project.
2. Constant Communication with the Contractor
3. Proof Rolling

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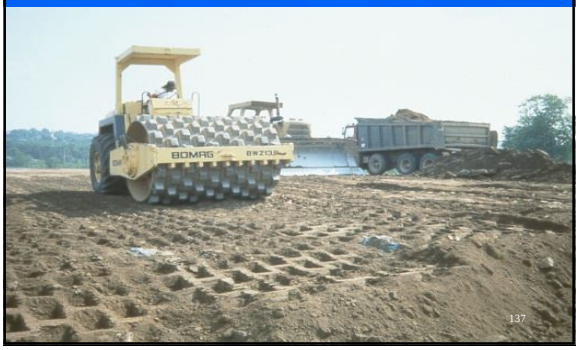
Excellent Material



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Good Conditions

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Solid/Stable Subgrade

139

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Communication With the Contractor

1. Constant
2. Ask Contractors Advice
3. Consult Regional Soils Engineer

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Approving Cuts and Shallow Fills

1. Shallow fills are defined as those 2 feet or less.
2. Stability of these areas is the responsibility of the Department.
3. These areas need to be approved by the Department prior to any further work.

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Subgrade Care

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Subgrade Care

- Maintain drainage during construction
- At the end of each work day consolidate and trim the subgrade to aid drainage
- Consolidate and trim the subgrade surface disturbed during construction.
- Seal the grade
- If rain is imminent during the workday, consolidate and trim the subgrade before the rain falls to avoid ponding and erosion.

144

Walls, Ponds, Signs

1. Walls
2. Ponds
3. Signs, Miscellaneous

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Walls

- Generally Walls Under 4 Feet Tall Are Considered Landscape Walls. Usually No Borings. Follow Manufacture's Recommendations.
- Walls Greater Than 4 Feet Tall Have Foundation Information and Requirements. There Are Specific Plans for These.
- If an Unplanned Wall is Proposed, Contact the Region Soils Engineer.

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Ponds

- Retention Ponds Have Requirements for Clay Liners so That Retained Water Does Not Contaminate the Ground Water.
- Clay Liner Specifications Are Usually in the Special Provisions of the Contract.
- May Also Be Lined With Riprap to Deter Wildlife.

150

Signs

- Ground Mount Signs: Typically 2 Posts With an Information Sign, Usually Don't Have Borings.
- Check Ground Where Sign is to Be Placed.
  Are there signs of any marsh, buried rock, etc.?
- Can Sign Be Moved? Check With Traffic Engineer.
- Large Signs (Cantilever, Overhead, etc.) Have Soil Borings. Borings Should Be Reviewed and Checked Against Field Conditions. If Something Looks Wrong Contact the Region's Soil Engineer.

151

Construction – Review

- The Contractor Must Clear and Grub the Entire Right of Way?
- All Items Removed by the Contractor Become the Property of the Contractor?
- The Engineer Should Not Be Concerned With Material Disposed Off the Right of Way?
- The Contactor Must Remove All Topsoil Directed By the Engineer?
- Borrow and Cut Soils Must Be Similar?

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Construction – Review

- The Engineer May Allow:
  - Thicker Initial Lifts at the Base of Fills to Achieve Initial Stability Over Softer Materials?
  - Lift Thickness Up to 1-foot, If Soils are Granular and Specialized Compaction Equipment is Used?
- Both Borrow and/or Cut Soils May Need Drying?
- The Contractor is Required to Proof Roll the Grade?

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