Yeager Airport Runway Extension:
Tallest Known Geosynthetic Reinforced 1H:1V Slope in N.A.

STGEC
Charleston, WV
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Presented by:
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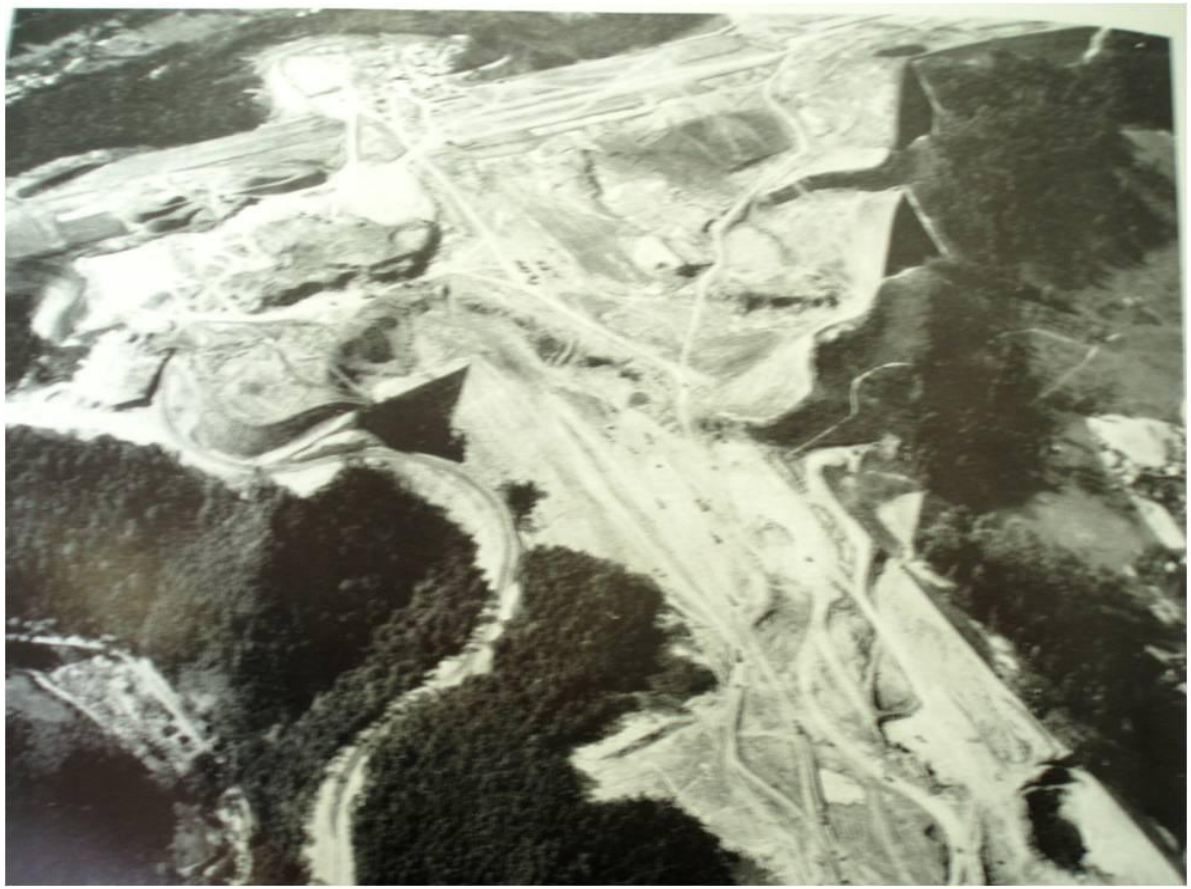
Yeager Airport History

- Yeager Airport in Charleston, WV, formerly known as Kanawha Airport, was completed in 1947.

- The Airport was constructed atop 7 semi-connected hilltops known as “Coonskin Ridge”.

Yeager Airport History



Grading operations 1946

Yeager Airport History

- Earthwork consisted of 6.8 million cubic meters (9 million cubic yards) of soil and rock. More than 900,000 Kg (2 million pounds) of explosives.

- Second largest earth moving project in the world, behind only the Panama Canal.

Yeager Airport History

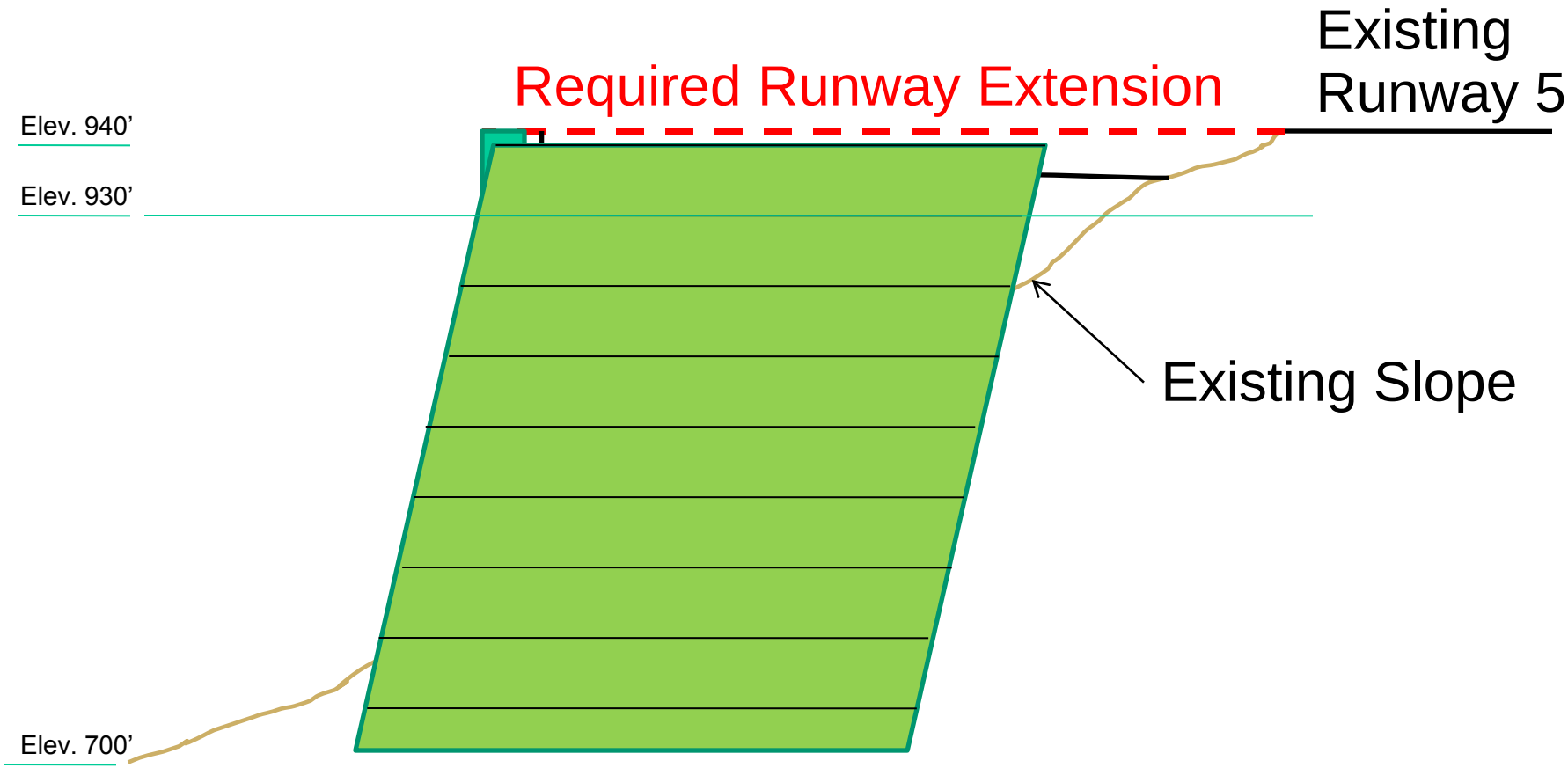
Airport at Grade,1947

Yeager Airport Expansion

- Due to FAA Safety Requirements it was necessary to extend Runway 5 approximately 150 meters (500 feet).

- The challenge: how to extend the runway out over a 91 meter (300 feet) slope?
  - Bridge, Wall and Slope Structures were all considered.

Yeager Airport Expansion



Yeager Airport Expansion

Runway 5
Slope Area

Subsurface Exploration

- Over 100 borings were performed.
- Extensive Laboratory Testing Including:
  - Proctors, gradations, Atterberg Limits, Triaxial Shear and Rock Core Compressive strengths.
- Site consisted of primarily of fill, colluvial and shallow rock.

Subsurface Exploration

- Slope bearing area consisted mainly of colluvial and sandstone rock.
  - RQD of Sandstone mostly above 70%.
  - Compressive strength of rock cores: 4,410 – 14,160 psi.
- Borrow area consisted mainly of weathered sandstone, sandstone and some claystone.
  - Max. Dry Density of sandstone: 122 – 133 pcf.
  - Internal Friction Angle: 38.9 – 39.6 degrees.

Soil Properties for Design

Soil Layer	Unit Weight, γ kN/m^3 (lb/ft^3)	Internal Friction Angle, Φ, degrees	Cohesion, c kPa
Reinforced Soil Zone	18.1 (115)	36	0
Retained Soil Zone	18.1 (115)	36	0
Bearing Soil Zone	22.0 (140)	40	0

Reinforced Slope Design

Reinforcement Type	Minimum LTDS (T_{al}), kN/m (lb/ft)
P-1	56.4 (3,861)
P-2	54.4 (3,725)
P-3	43.4 (2,971)

Where, LTDS (T_{al}) = T_{ult} / (RF_{CR} * RF_D * RF_{ID})

T_{ult} = Ultimate Tensile Strength of Reinforcement
RF_{CR} = Reduction Factor for Creep
RF_D = Reduction Factor for Durability
RF_{ID} = Reduction Factor for Installation Damage

Reinforced Slope Design

Reinforcement Type	Minimum Ultimate Tensile Strength Required (T_{ult}), kN/m (lb/ft)		
	PP	HDPE	PET
P-1	338.4 (23,166)	193.6 (13,251)	160.1 (10,968)
P-2	326.4 (22,350)	186.7 (12,785)	154.4 (10,581)
P-3	260.4 (17,826)	149.0 (10,197)	123.2 (8,439)

Typical Total Reduction Factors (RF_{CR}*RF_D*RF_{ID}) per FHWA:

PP =	4.84	(21% of Ultimate)
HDPE =	3.15	(32% of Ultimate)
PET =	2.0	(50% of Ultimate)

Reinforced Slope Design

Sieve Size	Specified Project Backfill, % Passing	Typical Backfill per FHWA, % Passing
152 mm (6 in)	100	
20 mm (3/4 in)		100
4.75 mm (No. 4)	30 to 100	20 to 100
0.85 mm (No. 20)	0 to 60	0 to 60
0.075 mm (No. 200)	0 to 50	0 to 50

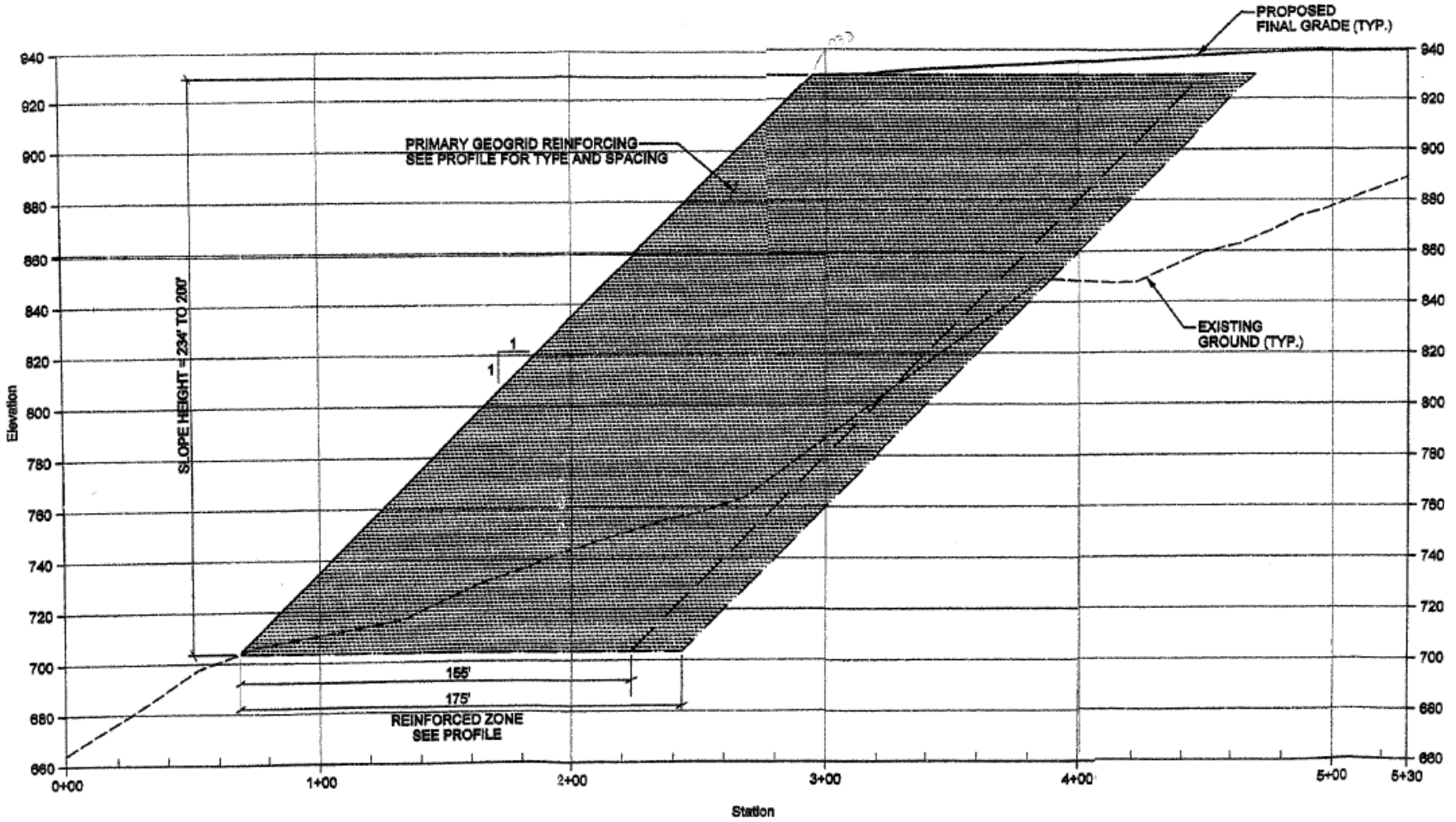
Due to allowance of up to 152 mm (6 inch) diameter rock fill, project specific installation damage testing was performed on proposed Miragrid reinforcement material.

Reinforced Slope Design

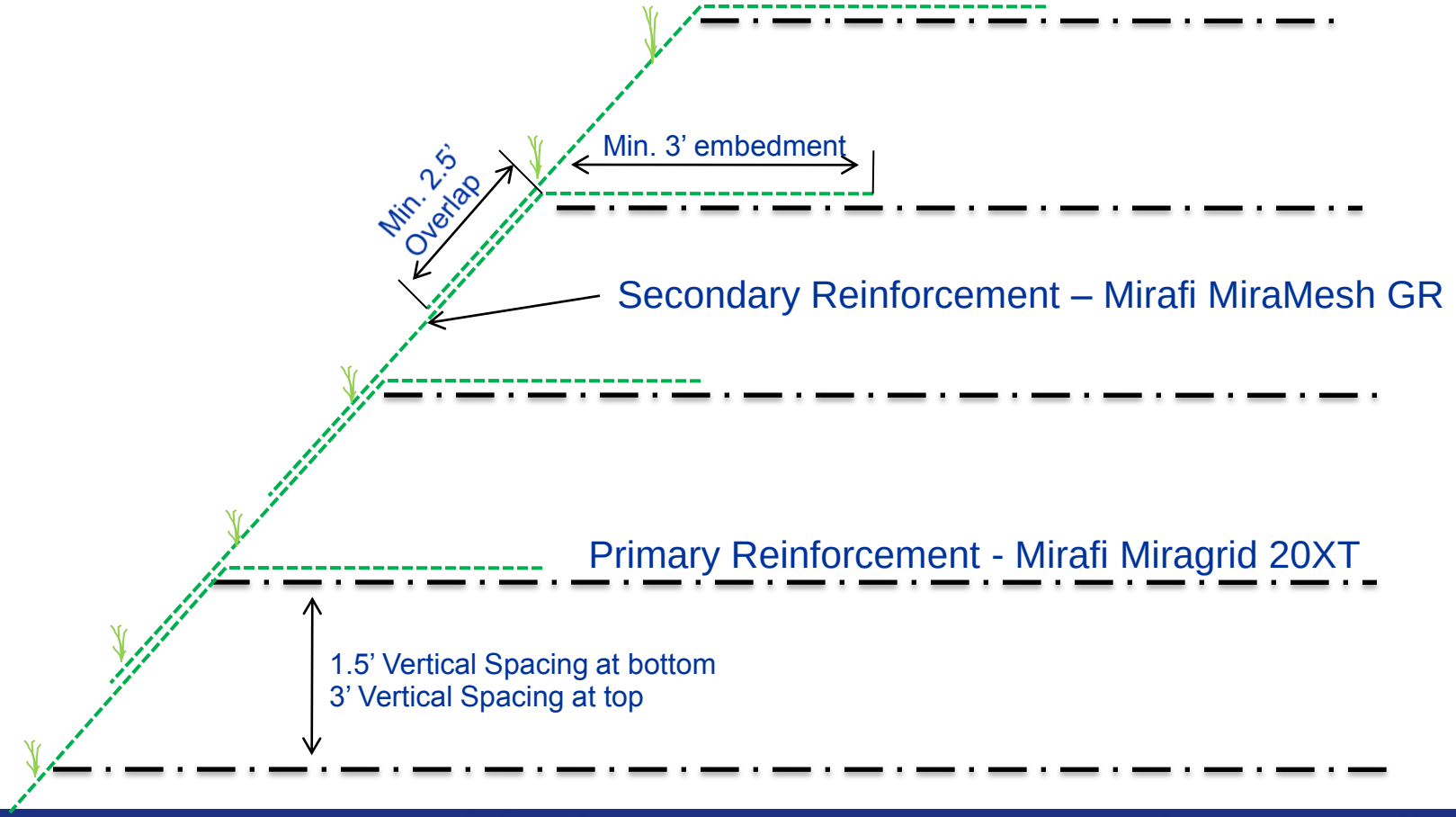
Reinforcement Type	Geosynthetic Used	Ultimate Tensile Strength, (T_{ult}) kN/m (lb/ft)
P-1	Mirafi Miragrid 20XT	187.9 (12,870)
P-2	Mirafi Miragrid 20XT	187.9 (12,870)
P-3	Mirafi Miragrid 10XT	145.2 (9,950)

Even though Miragrid XT Geogrids showed lower Reduction Factors for Installation Damage based on third party testing using the proposed coarse fill material, the higher reduction factors in the Specification were used for conservatism.

Slope Cross Section



Slope Cross Section



Reinforced Slope

- Embedment Lengths of Primary Reinfrocement ranged from 53 to 44 m (175 to 145 feet).

- Approximately 765,000 cubic meters (1 Million Cubic Yards) of Fill.

- 321,000 SM (384,000 SY) of Miragrid 20XT
- 214,000 SM (256,000 SY) of Miragrid 10XT
- 63,000 SM (75,000 SY) of MiraMesh GR

Reinforced Slope Construction

Yeager Airport Expansion

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Engineered Material Arrestor System

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On January 19, 2010 a US Airways flight bound for Charlotte aborted takeoff……..

……the CRJ 200 aircraft could not stop before the end of the runway……..

Engineered Material Arrestor System

Engineered Material Arrestor System

The jet was stopped approximately 150 feet from the edge of the slope by the EMAS…..

Engineered Material Arrestor System

All 34 passengers and crew survived the incident with only minor injuries reported.

Yeager Airport Expansion

Owner:
Central West Virginia Regional Airport Authority

Design Engineer:
Triad Engineering, St. Albans, WV

Contractor:
Cast & Baker, Canonsburg, PA - Rich Castagna

Material Supplier:
JMD Company, Pittsburgh, PA – Denny Long

Questions?

Thank You!

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Mirafi® Geosyntehtics

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