APPENDIX 11-X3

AREA III RECLAIMED CHANNELS
RIP-RAPPED DROP STRUCTURES

OCTOBER 2006

Note: The October 2006 FSC revision updates are in bold text at the end of each drop structure design.

03/10/03

BHP Navajo Coal Company
Navajo Mine
PO Box 1717
Fruitland, NM 87416

Riprap 2.0

AREA III RECLAIMED CHANNELS

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	663.0
Bottom Width, ft	25.00
Left Channel Side Slope	3.0 H:1V
Right Channel Side Slope	3.0 H:1V
Bottom Manning's "n"	0.0352
Left Manning's "n"	0.0352
Right Manning's "n"	0.0352
Channel Longitudinal Slope	0.01850

========== **ASCE Method** ==========

Input Parameters:

Run Name: LNDS1 Description: Lowe North Drop Str. 1 (LN Sta. 44+98 to 38+83)

Local Depth Averaged Velocity, ft/sec	8.76
Unit Weight of Stone, lbs/cu ft	165.00
Cotangent of Sideslope	3.00

Output Results:

Computed D50, ft	0.53

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.43
Specific Weight, pcf	165.00
Layer Thickness, ft	1.00
Selected Minimum D30, ft	0.49
Selected Minimum D90, ft	0.71

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	35	86
W50	17	26
W15	5	13

========== **USBR Method** ==========

Input Parameters:

Run Name: LNDS1 Description: Lowe North Drop Str. 1 (LN Sta. 44+98 to 38+83)

Average Channel Velocity, ft/sec 8.76

Output Results:

Computed D50, ft 1.07

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.87
Specific Weight, pcf	165.00
Layer Thickness, ft	2.00
Selected Minimum D30, ft	0.97
Selected Minimum D90, ft	1.41

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	276	691
W50	138	205
W15	43	102

========== **Isbash Method** ==========

Input Parameters:

Run Name: LNDS1 Description: Lowe North Drop Str. 1 (LN Sta. 44+98 to 38+83)

Average Channel Velocity, ft/sec	8.76
Unit Weight of Stone, lbs/cu ft	165.00
Turbulence Level	High

Output Results:

Computed D50, ft 0.98

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.80
Specific Weight, pcf	165.00
Layer Thickness, ft	1.75
Selected Minimum D30, ft	0.85
Selected Minimum D90, ft	1.23

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	185	463
W50	93	137
W15	29	69

========== **HEC-11 Method** ==========

Input Parameters:

Run Name: LNDS1 Description: Lowe North Drop Str. 1 (LN Sta. 44+98 to 38+83)

Average Channel Velocity, ft/sec	8.76
Average Flow Depth, ft	2.36
Unit Weight of Stone, lbs/cu ft	165.00
Material Angle of Repose, ø	39.00
Cotangent of Sideslope	3.00
Safety Factor	1.25

Output Results:

Computed D50, ft 0.58

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

- The rip-rap is designed for the peak flow from the 25 year-6 hour storm event. The drainage subdivisions used to model the hydrology is presented on Exhibit 11-77. The Sedcad results are presented in Appendix 11-X. LNDS1 is a rip-rapped drop structure, which will be located downstream of Structure 16 (Sedcad hydrology model).
- Use D50=1.0 foot riprap material.
- **From the updated hydrology for the October 2006 FSC revision the 25 yr-6 hr peak flow is 578 cfs, which is less than the design flow above. The rip-rap size specified is conservative; therefore the rip-rap sizing was not updated for the new flow.**

03/10/03

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Riprap 2.0

AREA III RECLAIMED CHANNELS

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	612.0
Bottom Width, ft	25.00
Left Channel Side Slope	3.0 H:1V
Right Channel Side Slope	3.0 H:1V
Bottom Manning's "n"	0.0360
Left Manning's "n"	0.0360
Right Manning's "n"	0.0360
Channel Longitudinal Slope	0.02270

========== ASCE Method ==========

Input Parameters:

Run Name: LNDS2 Description: Lowe North Drop Str. 2 (LN Sta.65+11 TO 54+87)

Local Depth Averaged Velocity, ft/sec	9.00
Unit Weight of Stone, lbs/cu ft	165.00
Cotangent of Sideslope	3.00

Output Results:

Computed D50, ft	0.56

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.46
Specific Weight, pcf	165.00
Layer Thickness, ft	1.00
Selected Minimum D30, ft	0.49
Selected Minimum D90, ft	0.71

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	35	86
W50	17	26
W15	5	13

========== **USBR Method** ==========

Input Parameters:

Run Name: LNDS2 Description: Lowe North Drop Str. 2 (LN Sta.65+11 TO 54+87)

Average Channel Velocity, ft/sec 9.00

Output Results:

Computed D50, ft 1.13

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.92
Specific Weight, pcf	165.00
Layer Thickness, ft	2.00
Selected Minimum D30, ft	0.97
Selected Minimum D90, ft	1.41

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	276	691
W50	138	205
W15	43	102

========== **Isbash Method** ==========

Input Parameters:

Run Name: LNDS2 Description: Lowe North Drop Str. 2 (LN Sta.65+11 TO 54+87)

Average Channel Velocity, ft/sec	9.00
Unit Weight of Stone, lbs/cu ft	165.00
Turbulence Level	High

Output Results:

Computed D50, ft 1.03

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.85
Specific Weight, pcf	165.00
Layer Thickness, ft	1.75
Selected Minimum D30, ft	0.85
Selected Minimum D90, ft	1.23

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	185	463
W50	93	137
W15	29	69

========== **HEC-11 Method** ==========

Input Parameters:

Run Name: LNDS2 Description: Lowe North Drop Str. 2 (LN Sta.65+11 TO 54+87)

Average Channel Velocity, ft/sec	9.00
Average Flow Depth, ft	2.16
Unit Weight of Stone, lbs/cu ft	165.00
Material Angle of Repose, ø	39.00
Cotangent of Sideslope	3.00
Safety Factor	1.25

Output Results:

Computed D50, ft 0.66

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

- The rip-rap is designed for the peak flow from the 25 year-6 hour storm event. The drainage subdivisions used to model the hydrology is presented on Exhibit 11-77. The Sedcad results are presented in Appendix 11-X. LNDS2 is a rip-rapped drop structure, which will be located downstream of Structure 6 (Sedcad hydrology model).
- Use D50=1.0 foot riprap material.
- **From the updated hydrology for the October 2006 FSC revision the 25 yr-6 hr peak flow is 553 cfs, which is less than the design flow above. The rip-rap size specified is conservative; therefore the rip-rap sizing was not updated for the new flow.**

03/10/03

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Riprap 2.0

AREA III RECLAIMED CHANNELS

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	126.0
Bottom Width, ft	10.00
Left Channel Side Slope	3.0 H:1V
Right Channel Side Slope	3.0 H:1V
Bottom Manning's "n"	0.0333
Left Manning's "n"	0.0333
Right Manning's "n"	0.0333
Channel Longitudinal Slope	0.02480

========== **ASCE Method** ==========

Input Parameters:

Run Name: LNDS3 Description: Lowe North Drop Str. 3 (LNR1 Sta. 0+00 to 6+00)

Local Depth Averaged Velocity, ft/sec	6.98
Unit Weight of Stone, lbs/cu ft	165.00
Cotangent of Sideslope	3.00

Output Results:

Computed D50, ft	0.34

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.28
Specific Weight, pcf	165.00
Layer Thickness, ft	0.75
Selected Minimum D30, ft	0.37
Selected Minimum D90, ft	0.53

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	15	36
W50	7	11
W15	2	5

========== **USBR Method** ==========

Input Parameters:

Run Name: LNDS3 Description: Lowe North Drop Str. 3 (LNR1 Sta. 0+00 to 6+00)

Average Channel Velocity, ft/sec 6.98

Output Results:

Computed D50, ft 0.67

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.55
Specific Weight, pcf	165.00
Layer Thickness, ft	1.25
Selected Minimum D30, ft	0.61
Selected Minimum D90, ft	0.88

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	67	169
W50	34	50
W15	11	25

========== **Isbash Method** ==========

Input Parameters:

Run Name: LNDS3 Description: Lowe North Drop Str. 3 (LNR1 Sta. 0+00 to 6+00)

Average Channel Velocity, ft/sec	6.98
Unit Weight of Stone, lbs/cu ft	165.00
Turbulence Level	High

Output Results:

Computed D50, ft 0.62

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.51
Specific Weight, pcf	165.00
Layer Thickness, ft	1.25
Selected Minimum D30, ft	0.61
Selected Minimum D90, ft	0.88

Percent Lighter by Weight	Minimum	Maximum
W100	67	169
W50	34	50
W15	11	25

========== **HEC-11 Method** ==========

Input Parameters:

Run Name: LNDS3 Description: Lowe North Drop Str. 3 (LNR1 Sta. 0+00 to 6+00)

Average Channel Velocity, ft/sec	6.98
Average Flow Depth, ft	1.30
Unit Weight of Stone, lbs/cu ft	165.00
Material Angle of Repose, ø	39.00
Cotangent of Sideslope	3.00
Safety Factor	1.25

Output Results:

Computed D50, ft 0.40

*** Using FHWA Gradation ***

Gradation Class	Facing
Layer Thickness, ft	1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

- The rip-rap is designed for the peak flow from the 25 year-6 hour storm event. The drainage subdivisions used to model the hydrology is presented on Exhibit 11-77. The Sedcad results are presented in Appendix 11-X. LNDS3 is a rip-rapped drop structure, which will be located downstream of Structure 15 (Sedcad hydrology model).
- Use D50=0.75 foot riprap material.
- **From the updated hydrology for the October 2006 FSC revision the 25 yr-6 hr peak flow is 126 cfs, which is equal to the design flow above. The rip-rap size specified is sufficient; therefore the rip-rap sizing was not updated for the new flow.**

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AREA III RECLAIMED CHANNELS

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	146.0
Bottom Width, ft	10.00
Left Channel Side Slope	3.0 H:1V
Right Channel Side Slope	3.0 H:1V
Bottom Manning's "n"	0.0385
Left Manning's "n"	0.0385
Right Manning's "n"	0.0385
Channel Longitudinal Slope	0.11500

ASCE Method

Input Parameters:

Run Name: LNDS4 Description: Lowe North Drop Str. 4 (LNR3 Sta. 10+06 to 6+25)

Local Depth Averaged Velocity, ft/sec	11.41
Unit Weight of Stone, lbs/cu ft	165.00
Cotangent of Sideslope	3.00

Output Results:

Computed D50, ft	0.90

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.74
Specific Weight, pcf	165.00
Layer Thickness, ft	1.75
Selected Minimum D30, ft	0.85
Selected Minimum D90, ft	1.23

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	185	463
W50	93	137
W15	29	69

========== **USBR Method** ==========

Input Parameters:

Run Name: LNDS4 Description: Lowe North Drop Str. 4 (LNR3 Sta. 10+06 to 6+25)

Average Channel Velocity, ft/sec 11.19

Output Results:

Computed D50, ft 1.77

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	1.45
Specific Weight, pcf	165.00
Layer Thickness, ft	3.00
Selected Minimum D30, ft	1.46
Selected Minimum D90, ft	2.12

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	933	2,333
W50	467	690
W15	146	345

========== **Isbash Method** ==========

Input Parameters:

Run Name: LNDS4 Description: Lowe North Drop Str. 4 (LNR3 Sta. 10+06 to 6+25)

Average Channel Velocity, ft/sec	11.19
Unit Weight of Stone, lbs/cu ft	165.00
Turbulence Level	High

Output Results:

Computed D50, ft 1.60

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	1.31
Specific Weight, pcf	165.00
Layer Thickness, ft	2.75
Selected Minimum D30, ft	1.34
Selected Minimum D90, ft	1.94

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	719	1,797
W50	359	532
W15	112	266

========== **HEC-11 Method** ==========

Input Parameters:

Run Name: LNDS4 Description: Lowe North Drop Str. 4 (LNR3 Sta. 10+06 to 6+25)

Average Channel Velocity, ft/sec	11.19
Average Flow Depth, ft	1.00
Unit Weight of Stone, lbs/cu ft	165.00
Material Angle of Repose, ø	39.00
Cotangent of Sideslope	3.00
Safety Factor	1.25

Output Results:

Computed D50, ft 1.86

*** Using FHWA Gradation ***

Gradation Class 1/2 ton
Layer Thickness, ft 3.38

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	2.85	2,000
D50	2.25	1,000
D5	1.80	500

- The rip-rap is designed for the peak flow from the 25 year-6 hour storm event. The drainage subdivisions used to model the hydrology is presented on Exhibit 11-77. The Sedcad results are presented in Appendix 11-X. LNDS4 is a rip-rapped drop structure, which will be located downstream of Structure 2 (Sedcad hydrology model)
- The riprap size required is D50=1.75 foot rock, this size rock is available in very limited quantity in the local area. Smaller size rock was placed and grouted with concrete.
- **From the updated hydrology for the October 2006 FSC revision the 25 yr-6 hr peak flow is 144 cfs, which is less than the design flow above. The rip-rap size specified is conservative; therefore the rip-rap sizing was not updated for the new flow.**

BHP Navajo Coal Company
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AREA III RECLAIMED CHANNELS

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	327.0
Bottom Width, ft	14.00
Left Channel Side Slope	3.0 H:1V
Right Channel Side Slope	3.0 H:1V
Bottom Manning's "n"	0.0412
Left Manning's "n"	0.0412
Right Manning's "n"	0.0412
Channel Longitudinal Slope	0.11500

========== **ASCE Method** ==========

Input Parameters:

Run Name: LNDS5 Description: Lowe North Drop Str. 5 (LNR4 Sta. 6+01 to 2+00)

Local Depth Averaged Velocity, ft/sec	12.94
Unit Weight of Stone, lbs/cu ft	165.00
Cotangent of Sideslope	3.00

Output Results:

Computed D50, ft	1.16

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.95
Specific Weight, pcf	165.00
Layer Thickness, ft	2.00
Selected Minimum D30, ft	0.97
Selected Minimum D90, ft	1.41

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	276	691
W50	138	205
W15	43	102

========== **USBR Method** ==========

Input Parameters:

Run Name: LNDS5 Description: Lowe North Drop Str. 5 (LNR4 Sta. 6+01 to 2+00)

Average Channel Velocity, ft/sec 12.94

Output Results:

Computed D50, ft 2.38

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	1.95
Specific Weight, pcf	165.00
Layer Thickness, ft	4.50
Selected Minimum D30, ft	2.19
Selected Minimum D90, ft	3.17

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	3,149	7,873
W50	1,575	2,330
W15	492	1,165

========== **Isbash Method** ==========

Input Parameters:

Run Name: LNDS5 Description: Lowe North Drop Str. 5 (LNR4 Sta. 6+01 to 2+00)

Average Channel Velocity, ft/sec	12.94
Unit Weight of Stone, lbs/cu ft	165.00
Turbulence Level	High

Output Results:

Computed D50, ft 2.14

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	1.75
Specific Weight, pcf	165.00
Layer Thickness, ft	4.00
Selected Minimum D30, ft	1.95
Selected Minimum D90, ft	2.82

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	2,212	5,529
W50	1,106	1,637
W15	346	818

========== **HEC-11 Method** ==========

Input Parameters:

Run Name: LNDS5 Description: Lowe North Drop Str. 5 (LNR4 Sta. 6+01 to 2+00)

Average Channel Velocity, ft/sec	12.94
Average Flow Depth, ft	1.39
Unit Weight of Stone, lbs/cu ft	165.00
Material Angle of Repose, ø	39.00
Cotangent of Sideslope	3.00
Safety Factor	1.20

Output Results:

Computed D50, ft 2.30

*** Using FHWA Gradation ***

Gradation Class 1 ton
Layer Thickness, ft 4.28

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	3.60	4,000
D50	2.85	2,000
D5	2.25	1,000

- The rip-rap is designed for the peak flow from the 25 year-6 hour storm event. The drainage subdivisions used to model the hydrology is presented on Exhibit 11-77. The Sedcad results are presented in Appendix 11-X. LNDS5 is a rip-rapped drop structure, which will be located downstream of Structure 3 (Sedcad hydrology model).
- The riprap size required is D50=2.5 foot rock, this size rock is available in very limited quantity in the local area. Smaller size rock was placed and grouted with concrete. The grouted rock will be broken up to resemble d50=2.5 foot rock.
- **From the updated hydrology for the October 2006 FSC revision the 25 yr-6 hr peak flow is 331 cfs, which is approximately equal to the design flow above. The rip-rap size specified should be sufficient, therefore the rip-rap sizing was not updated for the new flow.**

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AREA III RECLAIMED CHANNELS

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	509.0
Bottom Width, ft	25.00
Left Channel Side Slope	3.0 H:1V
Right Channel Side Slope	3.0 H:1V
Bottom Manning's "n"	0.0360
Left Manning's "n"	0.0360
Right Manning's "n"	0.0360
Channel Longitudinal Slope	0.02770

========== **ASCE Method** ==========

Input Parameters:

Run Name: LSDS1B Description: Lowe South Drop Str. 1 (LS Sta.44+61 to 33+20)

Local Depth Averaged Velocity, ft/sec	9.11
Unit Weight of Stone, lbs/cu ft	165.00
Cotangent of Sideslope	3.00

Output Results:

Computed D50, ft	0.57

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.47
Specific Weight, pcf	165.00
Layer Thickness, ft	1.00
Selected Minimum D30, ft	0.49
Selected Minimum D90, ft	0.71

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	35	86
W50	17	26
W15	5	13

========== **USBR Method** ==========

Input Parameters:

Run Name: LSDS1B Description: Lowe South Drop Str. 1 (LS Sta.44+61 to 33+20)

Average Channel Velocity, ft/sec 9.11

Output Results:

Computed D50, ft 1.16

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.95
Specific Weight, pcf	165.00
Layer Thickness, ft	2.00
Selected Minimum D30, ft	0.97
Selected Minimum D90, ft	1.41

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	276	691
W50	138	205
W15	43	102

========== **Isbash Method** ==========

Input Parameters:

Run Name: LSDS1B Description: Lowe South Drop Str. 1 (LS Sta.44+61 to 33+20)

Average Channel Velocity, ft/sec	9.11
Unit Weight of Stone, lbs/cu ft	165.00
Turbulence Level	High

Output Results:

Computed D50, ft 1.06

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.87
Specific Weight, pcf	165.00
Layer Thickness, ft	2.00
Selected Minimum D30, ft	0.97
Selected Minimum D90, ft	1.41

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	276	691
W50	138	205
W15	43	102

========== **HEC-11 Method** ==========

Input Parameters:

Run Name: LSDS1B Description: Lowe South Drop Str. 1 (LS Sta.44+61 to 33+20)

Average Channel Velocity, ft/sec	9.11
Average Flow Depth, ft	1.83
Unit Weight of Stone, lbs/cu ft	165.00
Material Angle of Repose, ø	39.00
Cotangent of Sideslope	3.00
Safety Factor	1.25

Output Results:

Computed D50, ft 0.74

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

- The rip-rap is designed for the peak flow from the 25 year-6 hour storm event. The drainage subdivisions used to model the hydrology is presented on Exhibit 11-77. The Sedcad results are presented in Appendix 11-X. LSDS1 is a rip-rapped drop structure, which will be located downstream of Structure 11 (Sedcad hydrology model).
- Use D50=1.0 foot riprap material.
- **From the updated hydrology for the October 2006 FSC revision the 25 yr-6 hr peak flow is 495 cfs, which is less than the design flow above. The rip-rap size specified is conservative; therefore the rip-rap sizing was not updated for the new flow.**

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AREA III RECLAIMED CHANNELS

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	165.0
Bottom Width, ft	15.00
Left Channel Side Slope	3.0 H:1V
Right Channel Side Slope	3.0 H:1V
Bottom Manning's "n"	0.0343
Left Manning's "n"	0.0343
Right Manning's "n"	0.0343
Channel Longitudinal Slope	0.03000

========== **ASCE Method** ==========

Input Parameters:

Run Name: LSDS2B Description: Lowe South Drop Str. 2 (Tributary to LS)

Local Depth Averaged Velocity, ft/sec	7.42
Unit Weight of Stone, lbs/cu ft	165.00
Cotangent of Sideslope	3.00

Output Results:

Computed D50, ft	0.38

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.31
Specific Weight, pcf	165.00
Layer Thickness, ft	0.75
Selected Minimum D30, ft	0.37
Selected Minimum D90, ft	0.53

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	15	36
W50	7	11
W15	2	5

========== **USBR Method** ==========

Input Parameters:

Run Name: LSDS2B Description: Lowe South Drop Str. 2 (Tributary to LS)

Average Channel Velocity, ft/sec 7.42

Output Results:

Computed D50, ft 0.76

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.62
Specific Weight, pcf	165.00
Layer Thickness, ft	1.50
Selected Minimum D30, ft	0.73
Selected Minimum D90, ft	1.06

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	117	292
W50	58	86
W15	18	43

========== **Isbash Method** ==========

Input Parameters:

Run Name: LSDS2B Description: Lowe South Drop Str. 2 (Tributary to LS)

Average Channel Velocity, ft/sec	7.42
Unit Weight of Stone, lbs/cu ft	165.00
Turbulence Level	High

Output Results:

Computed D50, ft 0.70

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.58
Specific Weight, pcf	165.00
Layer Thickness, ft	1.25
Selected Minimum D30, ft	0.61
Selected Minimum D90, ft	0.88

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	67	169
W50	34	50
W15	11	25

========== **HEC-11 Method** ==========

Input Parameters:

Run Name: LSDS2B Description: Lowe South Drop Str. 2 (Tributary to LS)

Average Channel Velocity, ft/sec	7.42
Average Flow Depth, ft	1.20
Unit Weight of Stone, lbs/cu ft	165.00
Material Angle of Repose, ø	39.00
Cotangent of Sideslope	3.00
Safety Factor	1.25

Output Results:

Computed D50, ft 0.50

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

- The rip-rap is designed for the peak flow from the 25 year-6 hour storm event. The drainage subdivisions used to model the hydrology is presented on Exhibit 11-77. The Sedcad results are presented in Appendix 11-X. LSDS2 is a rip-rapped drop structure, which will be located downstream of Structure 17 (Sedcad hydrology model).
- Use d50=0.75 foot riprap material.
- **From the updated hydrology for the October 2006 FSC revision the 25 yr-6 hr peak flow is 165 cfs, which is equal to the design flow above. The rip-rap size specified is sufficient; therefore the rip-rap sizing was not updated for the new flow.**

Bottom Manning's "n"	0.0352
Left Manning's "n"	0.0352
Right Manning's "n"	0.0352
Channel Longitudinal Slope	0.02940

========== **ASCE Method** ==========

Input Parameters:

Run Name: LSDS3B Description: Lowe South Drop Str. 3 (LS Sta. 249+21 to 245+61)

Local Depth Averaged Velocity, ft/sec	8.47
Unit Weight of Stone, lbs/cu ft	165.00
Cotangent of Sideslope	3.00

Output Results:

Computed D50, ft 0.50

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.41
Specific Weight, pcf	165.00
Layer Thickness, ft	1.00
Selected Minimum D30, ft	0.49
Selected Minimum D90, ft	0.71

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	35	86
W50	17	26
W15	5	13

========== **USBR Method** ==========

Input Parameters:

Run Name: LSDS3B Description: Lowe South Drop Str. 3 (LS Sta. 249+21 to 245+61)

Average Channel Velocity, ft/sec 8.47

Output Results:

Computed D50, ft 0.99

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.82
Specific Weight, pcf	165.00
Layer Thickness, ft	1.75
Selected Minimum D30, ft	0.85
Selected Minimum D90, ft	1.23

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	185	463
W50	93	137
W15	29	69

========== **Isbash Method** ==========

Input Parameters:

Run Name: LSDS3B Description: Lowe South Drop Str. 3 (LS Sta. 249+21 to 245+61)

Average Channel Velocity, ft/sec	8.47
Unit Weight of Stone, lbs/cu ft	165.00
Turbulence Level	High

Output Results:

Computed D50, ft	0.92

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.75
Specific Weight, pcf	165.00
Layer Thickness, ft	1.75
Selected Minimum D30, ft	0.85
Selected Minimum D90, ft	1.23

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	185	463
W50	93	137
W15	29	69

========== **HEC-11 Method** ==========

Input Parameters:

Run Name: LSDS3B Description: Lowe South Drop Str. 3 (LS Sta. 249+21 to 245+61)

Average Channel Velocity, ft/sec	8.47
Average Flow Depth, ft	1.57
Unit Weight of Stone, lbs/cu ft	165.00
Material Angle of Repose, ø	39.00
Cotangent of Sideslope	3.00
Safety Factor	1.25

========== **HEC-11 Method** ==========

Input Parameters:

Run Name: LSDS3B Description: Lowe South Drop Str. 3 (LS Sta. 249+21 to 245+61)

Average Channel Velocity, ft/sec	8.47
Average Flow Depth, ft	1.57
Unit Weight of Stone, lbs/cu ft	165.00
Material Angle of Repose, ø	39.00
Cotangent of Sideslope	3.00
Safety Factor	1.25

Output Results:

Computed D50, ft 0.64

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

- The rip-rap is designed for the peak flow from the 25 year-6 hour storm event. The drainage subdivisions used to model the hydrology is presented on Exhibit 11-77. The Sedcad results are presented in Appendix 11-X. LSDS3 is a rip-rapped drop structure, which will be located downstream of Structure 4 (Sedcad hydrology model).
- Use D50=1.0 foot riprap material.
- **From the updated hydrology for the October 2006 FSC revision the 25 yr-6 hr peak flow is 296 cfs, which is less than the design flow above. The rip-rap size specified is conservative; therefore the rip-rap sizing was not updated for the new flow.**
- **The 2006 Area 3 FSC revision the North Fork reclaimed channel requires no drop structure.**

Unit Weight of Stone, lbs/cu ft	165.00
Cotangent of Sideslope	3.00

Output Results:

Computed D50, ft	0.58

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.48
Specific Weight, pcf	165.00
Layer Thickness, ft	1.00
Selected Minimum D30, ft	0.49
Selected Minimum D90, ft	0.71

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	35	86
W50	17	26
W15	5	13

========== **USBR Method** ==========

Input Parameters:

Run Name: NFDS1 Description: North Fork Drop Str. (Sta. 15+55 to 12+25)

Average Channel Velocity, ft/sec 9.18

Output Results:

Computed D50, ft	1.17

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.96
Specific Weight, pcf	165.00
Layer Thickness, ft	2.00
Selected Minimum D30, ft	0.97
Selected Minimum D90, ft	1.41

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	276	691
W50	138	205
W15	43	102

Isbash Method

Input Parameters:

Run Name: NFDS1 Description: North Fork Drop Str. (Sta. 15+55 to 12+25)

Average Channel Velocity, ft/sec	9.18
Unit Weight of Stone, lbs/cu ft	165.00
Turbulence Level	Low

Output Results:

Computed D50, ft	0.55

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.45
Specific Weight, pcf	165.00
Layer Thickness, ft	1.00
Selected Minimum D30, ft	0.49
Selected Minimum D90, ft	0.71

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum
W100	35	86
W50	17	26
W15	5	13

HEC-11 Method

Input Parameters:

Run Name: NFDS1 Description: North Fork Drop Str. (Sta. 15+55 to 12+25)

Average Channel Velocity, ft/sec	9.18
Average Flow Depth, ft	3.11
Unit Weight of Stone, lbs/cu ft	165.00
Material Angle of Repose, ø	39.00
Cotangent of Sideslope	3.00
Safety Factor	1.25

Output Results:

Computed D50, ft	0.58

*** Using FHWA Gradation ***

Gradation Class	Facing
Layer Thickness, ft	1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	

- The rip-rap is designed for the peak flow from the 25 year-6 hour storm event. The drainage subdivisions used to model the hydrology is presented on Exhibit 11-77. The Sedcad results are presented in Appendix 11-Y. NFDS1 is a rip-rapped drop structure, which will be located downstream of Structure 35 (Sedcad hydrology model).
- Use D50=1.0 foot riprap material.

Drop Structure LNDS1, Capacity Design for 100 yr-6 hr Storm Event

Material: Riprap Material

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
25.00	3.0:1	3.0:1	1.9	0.0400	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	1,007.00 cfs	
Depth:	3.18 ft	4.18 ft
Top Width:	44.08 ft	50.08 ft
Velocity:	9.17 fps	
X-Section Area:	109.82 sq ft	
Hydraulic Radius:	2.435	
Froude Number:	1.02	

Drop Structure LNDS2, Capacity Design for 100 yr-6 hr Storm Event

Material: Riprap Material

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
25.00	3.0:1	3.0:1	2.3	0.0400	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	918.00 cfs	
Depth:	2.86 ft	3.86 ft
Top Width:	42.14 ft	48.14 ft
Velocity:	9.57 fps	
X-Section Area:	95.92 sq ft	
Hydraulic Radius:	2.227	
Froude Number:	1.12	

Drop Structure LNDS3, Capacity Design for 100 yr-6 hr Storm Event

Material: Riprap Material

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	3.0:1	3.0:1	2.5	0.0400	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	201.00 cfs	
Depth:	1.84 ft	2.84 ft
Top Width:	21.02 ft	27.02 ft
Velocity:	7.05 fps	
X-Section Area:	28.50 sq ft	
Hydraulic Radius:	1.318	
Froude Number:	1.07	

Drop Structure LNDS4, Capacity Design for 100 yr-6 hr Storm Event

Material: Riprap Material

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	3.0:1	3.0:1	7.1	0.0400	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	212.00 cfs	
Depth:	1.43 ft	2.43 ft
Top Width:	18.55 ft	24.55 ft
Velocity:	10.42 fps	
X-Section Area:	20.36 sq ft	
Hydraulic Radius:	1.070	
Froude Number:	1.75	

Drop Structure LNDS5, Capacity Design for 100 yr-6 hr Storm Event

Material: Riprap Material

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
14.00	3.0:1	3.0:1	8.0	0.0400	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	471.00 cfs	
Depth:	1.83 ft	2.83 ft
Top Width:	25.00 ft	31.00 ft
Velocity:	13.17 fps	
X-Section Area:	35.77 sq ft	
Hydraulic Radius:	1.397	
Froude Number:	1.94	

Drop Structure LSDS1, Capacity Design for 100 yr-6 hr Storm Event

Material: Riprap Material

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
25.00	3.0:1	3.0:1	2.8	0.0400	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	763.00 cfs	
Depth:	2.44 ft	3.44 ft
Top Width:	39.64 ft	45.64 ft
Velocity:	9.68 fps	
X-Section Area:	78.84 sq ft	
Hydraulic Radius:	1.950	
Froude Number:	1.21	

Drop Structure LSDS2, Capacity Design for 100 yr-6 hr Storm Event

Material: Riprap Material

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
15.00	3.0:1	3.0:1	3.0	0.0400	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	250.00 cfs	
Depth:	1.64 ft	2.64 ft
Top Width:	24.85 ft	30.85 ft
Velocity:	7.64 fps	
X-Section Area:	32.72 sq ft	
Hydraulic Radius:	1.289	
Froude Number:	1.17	

Drop Structure LSDS3, Capacity Design for 100 yr-6 hr Storm Event

Material: Rip-rap Material

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
18.00	3.0:1	3.0:1	2.9	0.0400	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	426.00 cfs	
Depth:	2.03 ft	3.03 ft
Top Width:	30.20 ft	36.20 ft
Velocity:	8.69 fps	
X-Section Area:	49.00 sq ft	
Hydraulic Radius:	1.588	
Froude Number:	1.20	

Drop Structure NFDS1, Capacity Design for 100 yr-6hr Storm Event

Material: Rip-rap Material

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
25.00	3.0:1	3.0:1	1.5	0.0400	1.00			15.0

	w/o Freeboard	w/ Freeboard
Design Discharge:	1,416.00 cfs	
Depth:	4.01 ft	5.01 ft
Top Width:	49.06 ft	55.06 ft
Velocity:	9.54 fps	
X-Section Area:	148.49 sq ft	
Hydraulic Radius:	2.949	
Froude Number:	0.97	