Cumulative Hydrologic Impact Assessment

Of the

Navajo Mine and Pinabete Permit Areas

Prepared By

Office of Surface Mining Reclamation and Enforcement

Indian Program Branch, Program Support Division

Western Region Office – Denver, Colorado

March 2015

TABLE OF CONTENTS

LIST OF FIGURES 6
LIST OF TABLES 7
LIST OF APPENDICES 8
LIST OF ACRONYMS 9
1 INTRODUCTION 10
1.1 Regulatory Environment 12
1.1.1 CHIA Revision Rationale 13
1.1.2 Cumulative Impact Area 13
1.1.3 Material Damage to the Hydrologic Balance 13
1.1.4 Material Damage Criteria 14
1.2 Background 14
1.2.1 Climate 15
1.2.2 Regional Geology 15
2 DELINEATION OF CUMULATIVE IMPACT AREA 22
2.1 Surface Water Cumulative Impact Area 22
2.1.1 Cumulative Surface Water Impact Potential 22
2.1.2 Impact Potential to the San Juan River 26
2.1.3 Impact Potential to the Chaco River 30
2.1.4 Surface Water Impact Area 31
2.2 Ground Water Cumulative Impact Area 32
2.2.1 Ground Water Impact Area 32
3 WATER RESOURCE USES AND DESIGNATIONS 36
3.1 Direct Human Use 36
3.2 Industrial Supply Water 37
3.3 Irrigation Supply Water 38
3.4 Livestock Supply Water 39
3.5 Aquatic and Wildlife Habitat Water Supply 40
4 BASELINE HYDROLOGIC CONDITIONS 44
4.1 Surface Water 44
4.1.1 Surface Water Regulatory Requirements 44
4.1.2 Surface Water Regime 45
4.1.3 El Segundo Mine 45
4.1.4 Morgan Lake 46

4.1.5 Chaco River 48
4.1.5.1 Surface Water Quantity 48
4.1.5.2 Surface Water Quality 48
4.1.5.2.1 Methodology 48
4.1.5.2.2 Analysis 50
4.1.6 Historic Mining Area North of the Navajo and Pinabete Permit Areas 50
4.1.7 Navajo Mine and Pinabete Permit Areas 50
4.1.7.1 Surface Water Baseline Quantity 50
4.1.7.1.1 Morgan Lake-Chaco River Watershed 54
4.1.7.1.2 Chinde Wash Watershed 54
4.1.7.1.3 Chinde Wash-Chaco River Watershed 54
4.1.7.1.4 Coal Creek-Chaco River Watershed 55
4.1.7.1.5 Cottonwood Arroyo Watershed 55
4.1.7.2 Surface Water Baseline Quality 55
4.1.7.2.1 Baseline with NAPI 56
4.1.7.2.1.1 Chinde Wash 56
4.1.7.2.1.2 Cottonwood Arroyo 57
4.1.7.2.2 Baseline without NAPI 58
4.2 Ground Water 59
4.2.1 Ground Water Regulatory Requirements 59
4.2.2 Chaco River Alluvium 59
4.2.3 Historic Mining Area North of Navajo Mine and Pinabete Permit Areas 60
4.2.4 Navajo Mine and Pinabete Permit Areas 62
4.2.4.1 Alluvial Baseline Quantity 62
4.2.4.2 Alluvial Baseline Quality 63
4.2.4.3 Fruitland Formation Baseline Quantity 64
4.2.4.4 Fruitland Formation Baseline Quality 65
4.2.4.5 Pictured Cliffs Sandstone Aquifer Baseline Quantity 66
4.2.4.6 Pictured Cliffs Sandstone Aquifer Baseline Quality 67
5 HYDROLOGIC IMPACT ASSESSMENTS 70
5.1 Minimization of Impact 70
5.2 Monitoring Program 70
5.2.1.1 Monitoring Program Updates 71
5.3 Impact Assessment 73
5.3.1 Potential Cumulative Impact between NTEC operations and El Segundo Mine 76
5.3.2 Potential Impact of NTEC operations on NAPI 76

5.3.3 Potential Impact of NTEC Operations on Morgan Lake and APS 76
5.3.4 Chaco River 77
5.3.4.1 Surface Water Quantity 77
5.3.4.2 Surface Water Quality 78
5.3.4.3 Chaco River Alluvium 79
5.3.5 Historic Mining Area North of the NTEC Permit Areas 79
5.3.5.1 Surface Water 79
5.3.5.2 Alluvium 80
5.3.5.3 Fruitland Formation and PCS 81
5.3.5.3.1 CCB Disposal 82
5.3.6 Navajo Mine and Pinabete Permit Areas 85
5.3.6.1 Surface Water Quantity 85
5.3.6.1.1 Morgan Lake-Chaco River Watershed 86
5.3.6.1.2 Chinde Wash Watershed 86
5.3.6.1.3 Chinde-Chaco River Watershed 87
5.3.6.1.4 Coal Creek-Chaco River Watershed 89
5.3.6.1.5 Cottonwood Arroyo Watershed 90
5.3.6.2 Surface Water Quality 91
5.3.6.2.1 Chinde Wash 92
5.3.6.2.2 Cottonwood Wash 93
5.3.7 Groundwater 93
5.3.7.1 Alluvium 93
5.3.7.1.1 Alluvial Quantity 94
5.3.7.1.2 Alluvial Quality 96
5.3.7.1.2.1 Bighan Alluvium 96
5.3.7.1.2.2 Chinde Wash Alluvium 97
5.3.7.1.2.3 Cottonwood Arroyo Alluvium 99
5.3.7.2 Fruitland Formation Quantity 100
5.3.7.3 Fruitland Formation Quality 101
5.3.7.4 Pictured Cliffs Sandstone Quantity 103
5.3.7.5 Pictured Cliffs Sandstone Quality 104
6 MATERIAL DAMAGE 106
6.1 Cumulative Impact of NTEC Operations and El Segundo Mine 106
6.2 NTEC Operations Impact on NAPI 106
6.3 NTEC Operations Impact to Morgan Lake and APS 106
6.4 Chaco River 106

6.5 Historic Mining North of the Navajo Mine Permit 107
6.6 Navajo Mine and Pinabete Permit Area 107
6.6.1 Material Damage Assessment 109
6.6.1.1 Surface Water 109
6.6.1.2 Alluvium 110
6.6.1.3 Fruitland Formation and PCS 110
6.6.2 Conclusion 110
7 WORKS CITED 111

LIST OF FIGURES

Figure 1: NTEC Navajo Mine and Pinabete Permit Areas 17
Figure 2: Navajo Tribal Coal Lease Location Map 18
Figure 3: San Juan Basin Structural Geology 19
Figure 4: Navajo Tribal Coal Lease Area and Surrounding Area Stratigraphy 20
Figure 5: Surface Geology Map, NW New Mexico 21
Figure 6: Navajo Tribal Coal Lease Primary Drainages and HUC 12 Watersheds 23
Figure 7: Historical and Existing Coal Mining, San Juan Watershed 24
Figure 8: USGS Active and Historical Gaging Stations, San Juan Watershed 27
Figure 9: San Juan River Discharge and Mine Operational Period Comparison (1931-2010) 28
Figure 10: San Juan River TDS and Mine Operational Period Comparison (1957-2010) 29
Figure 11: Surface Water CIA and Non-NTEC Surface Water Impoundments 34
Figure 12: Groundwater CIA and Non-NTEC use Wells 35
Figure 13: Non-NTEC Surface Water Impoundments within the vicinity of the Navajo Tribal Coal Lease 42
Figure 14: Select Tributary Irrigation Project Lands 43
Figure 15: PCS Potentiometric surface and Outcrop Location 47
Figure 16: Baseline Monthly Flow along the Chaco River 48
Figure 17: Surface Water Monitoring Locations 52
Figure 18: SEDCAD Modeled Sub-Drainages 53
Figure 19: Groundwater Monitoring Locations 61
Figure 20: No. 3 Coal Seam Potentiometric Surface 68
Figure 21: No. 8 Coal Seam Potentiometric Surface 69
Figure 22: Chinde Diversion and Monitoring Locations 74
Figure 23: Monthly Flow along the Chaco River 78
Figure 24: Custer Water Elevations 81
Figure 25: Approximate Pre-2008 Coal Combustion By-Product (CCB) Placement Area 84
Figure 26: Percentage of the Morgan Lake-Chaco River Watershed Managed by Impoundments 86
Figure 27: Percentage of the Chinde-Chaco River Watershed Managed by Impoundments 88
Figure 28: Percentage of the Coal Creek Watershed Managed by Impoundments 90
Figure 29: Percentage of the Cottonwood Arroyo Watershed Managed by Impoundments 91
Figure 30: Chinde and Bighan Alluvial Water Elevations 95
Figure 31: Chinde Alluvium Concentrations over Time 99
Figure 32: Post-Mining Potentiometric Surface in the PCS Aquifer (NTEC 2013) 105

LIST OF TABLES

Table 1: Navajo Mine and Pinabete Permit Area – Material Damage Summary 11

Table 2: Mining History in the San Juan Watershed 25

Table 3: Surface Water Criteria 49

Table 4: Chinde-Wash Chaco River Sub-Watershed Details 54

Table 5: Coal Creek Sub-Watershed Details 55

Table 6: Chinde Alluvium Monitoring Approach (BNCC 2012, MMCo. 2015) 73

Table 7: Impact Assessment and Designation Methodology 75

Table 8: Comparison of Pre-Mine and Post-Mine Peak Flows in the Chinde Wash Watershed (NTEC 2013) 87

Table 9: Comparison of Pre-Mine and Post-Mine Peak Flows in Chinde-Chaco River Watershed 88

Table 10: Comparison of Pre-Mine and Post-Mine Peak Flows in Chinde-Chaco River Watershed 89

Table 11: Comparison of Pre-mine and Post-Mine Peak Flows in the Cottonwood Arroyo Watershed (NTEC 2013) 91

Table 12: Material Damage Limits and Hydrologic Balance Thresholds 108

Table 13: Assessment of Material Damage for the Waters of the Navajo Mine 109

LIST OF APPENDICES

Appendix A: USGS Data for the San Juan River

Appendix B: Water Uses

Appendix C: Navajo Mine Impoundments

Appendix D: Surface Water Data Summary

Appendix E: SEDCAD Modeling Reports

Appendix F: Groundwater Data Summary

Appendix G: Coal Combustion Byproducts Assessment

Appendix H: Hydrologic Monitoring Program Enhancements Technical Memorandum

LIST OF ACRONYMS

%RSD	Percent Relative Standard Deviation
AOC	Approximate Original Contour
APS	Arizona Public Service
AST	Above-Ground Storage Tank
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BMP	Best Management Practice
BNCC	BHP Navajo Coal Company
CCB	Coal Combustion Byproduct
CFR	Code of Federal Regulations
CHIA	Cumulative Hydrologic Impact Assessment
CIA	Cumulative Impact Area
CWA	Clean Water Act
FCPP	Four Corners Power Plant
HUC	Hydrologic Unit Code
LOM	Life-of-Mine
MAD	Median Absolute Deviation
MMCo.	BHP Mine Management Company
MSL	Mean Sea Level
NAPI	Navajo Agricultural Products Industry
NHD	National Hydrologic Database
NIST	National Institute of Standards and Technology
NMEMNRD	New Mexico Energy Minerals and Natural Resource Division
NNEPA	Navajo Nation Environmental Protection Agency
NTEC	Navajo Transitional Energy Company, LLC
NPDES	National Pollution Discharge Elimination System
OSMRE	Office of Surface Mining Reclamation and Enforcement
PAP	Permit Application Package
PCS	Pictured Cliff Sandstone
PHC	Probable Hydrologic Consequences
SMCRA	Surface Mining Control and Reclamation Act of 1977
TDS	Total Dissolved Solids
TOJ	Termination of Jurisdiction
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VWP	Vibrating Wire Piezometer