Technical Memorandum

Date: November 17, 2009

To: Gregory S. Olsen, ADEQ

From: Clifton F. Bell, Malcolm Pirnie

Re: Revisions to Pinto Creek Background/Ambient Model and Current Conditions Scenarios

Project No.: 1761-117

The purpose of this memo is to present the results of the natural/ambient and current conditions scenarios of the revised Pinto Creek HSPF model of copper transport. The original model was documented in the reported entitled *Pinto Creek Phase II TMDL Modeling Report* (Malcolm Pirnie, 2006). The model was subsequently revised as described in the technical memorandum entitled *Revisions to Pinto Creek Background/Ambient Model Scenario* (Malcolm Pirnie, 9 Sep 2008). These revisions included the revision of background concentrations associated with selected lithologies and recalibration of the model. The model version discussed in this memo is identical to the September 2008 version, with the exception of a few minor corrections to runoff concentrations associated with mining-related sources.

Definition of Natural/Ambient Model Scenarios: Background concentrations associated with different lithologies and locations are summarized in Table 1. As described in the September 2008 technical memo, two versions of the natural/ambient modeling scenarios were created. The first version, abbreviated NatAmb, had the copper loads of mining-related sources set to ten times background levels. The second version, abbreviated NatAmb2, had the copper loads of mining-related sources set to background levels.

Definition of Current Conditions Model Scenario: In the Current Conditions model scenario, all copper-related model parameters (POTFW, AOQC, IOQC) are set to values of the recalibrated model. However, rather than being run with the observed meteorological data (Meteo.wdm), it was run with the same five design storms used to evaluate the other model scenarios (Storm.wdm). This will allow a direct comparison of the copper concentrations and loads between current conditions and natural ambient scenarios.

Model Output Locations Added: The HSPF model was designed provide output (copper concentrations and loads) at the following in-stream locations:

1. Pinto Creek above Henderson Ranch Mines
2. Pinto Creek above Gibson Tributary
3. Gibson Tributary

4. Unnamed Tributary #2
5. Five Point Mountain Tributary
6. Pinto Creek at PC-100
7. Pinto Creek below Cactus Breccia
8. Haunted Canyon
9. Pinto Creek at PC-200
10. Pinto Creek above West Fork Pinto Creek
11. West Fork Pinto Creek
12. Pinto Creek at PC-300
13. Pinto Creek at Basin Exit

The italicized locations in the list above represent new model output locations, relative to previous versions of the model. A special note must be made regarding output location 10 (Pinto Creek above West Fork Pinto Creek), which occurs in the middle of RCHRES 32. The output of RCHRES 32 is used in the default model files to represent Pinto Creek at PC-300. In order to obtain output for location 10, separate uci files were created in which RCHRES 27, 28, 30 and 31 were re-routed from RCHRES 32 to RCHRES 33 (lower Pinto Creek). The re-routed tributaries enter Pinto Creek downstream from output location 10, and thus allow the output of RCHRES 32 to represent location 10.

TABLE 1
Simulated Background Concentrations of Dissolved Copper Of Runoff in the Pinto Creek Basin
[Shaded rows indicate revisions from 2006 model]

Lithology/Location	Revised Representative Sample Locations	2006 Diss. Cu Conc. (µg/L)	Revised Diss. Cu Conc. (µg/L)
Schultz Granite	102657, 102687, 102688, 102690	39.5	35.1
Schist	102650, 102651, 102652, 102653,102654, 102656	32.2	27.8
Dacite	102665, 102668	25	25
Alluvium upstream of confluence with W. Fork Pinto Creek	100346, 101068, 101070, 102434, 102435	24	15
Other alluvium			12
Mixed; West Fork Pinto Creek	102433	7.5	7.5
Mixed; Haunted Canyon	101072, 101131	7.9	7.9
Mixed; Powers Gulch	102665	21	21
Mixed; Above Henderson Ranch Mines	102428, 101039	12	12
Mixed; Mowing Machine Basin	102667	19	19
Mixed; Pinto Creek Below PC-300	101070, 100346	7.5	7.5

Model Files: The following model-related files accompany this memo:

- User's Control Input files
  - Pinto_rev.uci: The revised calibration scenario.
  - NatAmb_rev.uci: The revised natural ambient scenario with mining-related sources set to ten times background.
  - NatAmb_rev_X.uci: The version of NatAmb_rev.uci in which RCHRESes were re-routed to generate output for location 10.
  - NatAmb2_rev.uci: The revised natural ambient scenario with mining-related sources set to background.
  - NatAmb2_rev_X.uci: The version of NatAmb2_rev.uci in which RCHRESes were re-routed to generate output for location 10.
  - Current_Cond.uci: The current conditions scenario.
  - Current_Cond_X.uci: The version of the current conditions scenario in which RCHRESes were re-routed to generate output for location 10.
- Watershed Data Management files
  - Meteo.wdm: Input data for Pinto_rev.uci
  - Storms.wdm: Input data for all other uci files
  - Pinto_rev.wdm: Output file for Pinto_rev.uci
  - Scenarios_rev.wdm: Output file for NatAmb_rev.uci
  - Scenarios_rev_X.: Output file for NatAmb_rev_X.uci
  - Scenarios2_rev.wdm: Output file for NatAmb2_rev.uci
  - Scenarios2_rev_X.wdm: Output file for NatAmb2_rev_X.uci
  - Current_Cond.wdm: Output file for Current_Cond.uci
  - Current_Cond_X.wdm: Output file for Current_Cond_X.uci

It should be noted that the "scenarios" family of WDM files contains data sets for multiple scenarios described in the original 2006 modeling report. However, only the NatAmb scenario should be used. The other scenario results have not been updated from the 2006 report, but were retained in the WDM files in case ADEQ chooses to update those scenarios in the future.

Output of Natural/Ambient Scenarios: The results of the NatAmb and NatAmb2 scenarios are provided in the attached tables as follows:

- Tables 2, 3, and 4: Maximum in-stream copper concentrations associated with the NatAmb, NatAmb2, and Current Conditions scenarios.
- Tables 5, 6, and 7: In-stream copper loads associated with NatAmb, NatAmb2, and Current Conditions scenarios.
- Tables 8, 9, and 10: Copper loads from specific mining-related sources associated with NatAmb, NatAmb2, and Current Conditions scenarios.

When modeling reaches that experience large changes in flow and load over short time steps, HSPF can overestimate maximum in-stream concentrations for short time steps. However, the flow and copper mass balance for the storm as a whole are preserved. For

this reason, in-stream copper concentrations are tabulated in the memo as storm averages (Tables 2, 3, and 4). Monitoring data indicate that in-stream copper concentrations at specific locations tend to fluctuate around an average value, and the HSPF model is calibrated to these average storm concentrations. Hence, copper concentrations during actual storms would be expected to fluctuate both above and below the values tabulated in Tables 2, 3 and 4. The variability of observed monitoring data could be used to estimate the magnitude of this fluctuation.

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Attachments

TABLE 2
Model Predictions of Dissolved Copper Concentrations (ug/L)
for Background/Ambient Model Scenario with Mining Sources Set to Ten Times Background

Location	Storm Event				
	2-yr, 1-hr	2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
1. Pinto Cr above H.R. Mine Chronic criterion = 16.2 ug/L Acute criterion = 25.8 ug/L	10.9	8.9	10.5	10.7	10.8
2. Pinto Creek above Gibson Chronic criterion = 6.6 ug/L Acute criterion = 9.6 ug/L	19.7	14.0	18.4	18.9	19.1
3. Gibson Tributary Chronic criterion = 6.1 mg/L Acute criterion = 8.8 ug/L	42.4	37.5	41.5	41.9	42.1
4. Unnamed Tributary #2 Chronic criterion = 3.1 ug/L Acute criterion = 4.2 ug/L	37.5	33.0	36.9	37.0	37.1
5. Five Point Mountain Tributary Chronic criterion = 3.1 ug/L Acute criterion = 4.2 ug/L	37.5	33.0	36.9	37.0	37.1
6. PC-100 Chronic criterion = 8.2 ug/L Acute criterion = 12.2 ug/L	23.6	15.8	22.1	22.7	22.8
7. Below Cactus Breccia Chronic criterion = 22.8 ug/L Acute criterion = 37.7 ug/L	27.5	23.0	26.3	25.9	25.4
8. Haunted Canyon Chronic criterion = 14.1 ug/L Acute criterion = 22.2 ug/L	11.7	11.2	11.7	11.8	11.8
9. PC-200 Chronic criterion = 12.7 ug/L Acute criterion = 19.7 ug/L	20.3	18.0	20.1	20.2	20.2
10. Pinto Cr abv W Fk Pinto Cr Chronic criterion = 12.7 ug/L Acute criterion = 19.7 ug/L	11.7	9.8	10.6	10.5	10.1
11. West Fork Pinto Creek Chronic criterion = 10.5 ug/L Acute criterion = 16.0 ug/L	7.4	4.4	6.3	6.4	5.3
12. PC-300 Chronic criterion = 29.3 ug/L Acute criterion = 49.6 ug/L	11.2	9.2	10.3	10.3	10.1
13. Basin Exit Chronic criterion = 16.6 ug/L Acute criterion = 26.4 ug/L	11.2	8.5	10.2	10.2	9.9

TABLE 3
Model Predictions of Dissolved Copper Concentrations (ug/L)
for Background/Ambient Model Scenario with Mining Sources Set to Background

Location	Storm Event				
	2-yr, 1-hr	2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
1. Pinto Cr above H.R. Mine Chronic criterion = 16.2 ug/L Acute criterion = 25.8 ug/L	10.9	8.9	10.5	10.7	10.8
2. Pinto Creek above Gibson Chronic criterion = 6.6 ug/L Acute criterion = 9.6 ug/L	19.2	13.7	18.0	18.5	18.7
3. Gibson Tributary Chronic criterion = 6.1 mg/L Acute criterion = 8.8 ug/L	27.8	24.5	27.1	27.4	27.4
4. Unnamed Tributary #2 Chronic criterion = 3.1 ug/L Acute criterion = 4.2 ug/L	34.9	30.6	34.2	34.4	34.5
5. Five Point Mountain Tributary Chronic criterion = 3.1 ug/L Acute criterion = 4.2 ug/L	34.9	30.6	34.2	34.4	34.5
6. PC-100 Chronic criterion = 8.2 ug/L Acute criterion = 12.2 ug/L	22.7	14.9	21.1	21.8	21.9
7. Below Cactus Breccia Chronic criterion = 22.8 ug/L Acute criterion = 37.7 ug/L	26.1	21.8	25.0	24.7	24.1
8. Haunted Canyon Chronic criterion = 14.1 ug/L Acute criterion = 22.2 ug/L	11.7	11.2	11.7	11.8	11.8
9. PC-200 Chronic criterion = 12.7 ug/L Acute criterion = 19.7 ug/L	18.6	16.3	18.4	18.5	18.4
10. Pinto Cr abv W Fk Pinto Cr Chronic criterion = 12.7 ug/L Acute criterion = 19.7 ug/L	9.9	8.3	9.4	9.4	9.2
11. West Fork Pinto Creek Chronic criterion = 10.5 ug/L Acute criterion = 16.0 ug/L	7.4	4.4	6.3	6.4	5.3
12. PC-300 Chronic criterion = 29.3 ug/L Acute criterion = 49.6 ug/L	9.7	7.9	9.2	9.2	9.2
13. Basin Exit Chronic criterion = 16.6 ug/L Acute criterion = 26.4 ug/L	9.7	7.3	9.0	9.1	9.0

TABLE 4
Model Predictions of Dissolved Copper Concentrations (ug/L)
for Current Conditions Model Scenario

Location	Storm Event				
	2-yr, 1-hr	2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
1. Pinto Cr above H.R. Mine Chronic criterion = 16.2 ug/L Acute criterion = 25.8 ug/L	10.9	8.9	10.5	10.7	10.8
2. Pinto Creek above Gibson Chronic criterion = 6.6 ug/L Acute criterion = 9.6 ug/L	26.6	17.7	24.4	25.1	25.4
3. Gibson Tributary Chronic criterion = 6.1 mg/L Acute criterion = 8.8 ug/L	6,210	5,151	5,970	6,022	6,069
4. Unnamed Tributary #2 Chronic criterion = 3.1 ug/L Acute criterion = 4.2 ug/L	115	101	113	114	114
5. Five Point Mountain Tributary Chronic criterion = 3.1 ug/L Acute criterion = 4.2 ug/L	115	101	113	114	114
6. PC-100 Chronic criterion = 8.2 ug/L Acute criterion = 12.2 ug/L	374	323	384	374	363
7. Below Cactus Breccia Chronic criterion = 22.8 ug/L Acute criterion = 37.7 ug/L	118	104	121	119	118
8. Haunted Canyon Chronic criterion = 14.1 ug/L Acute criterion = 22.2 ug/L	11.7	11.2	11.7	11.8	11.8
9. PC-200 Chronic criterion = 12.7 ug/L Acute criterion = 19.7 ug/L	50.2	44.0	53.3	54.4	55.0
10. Pinto Cr abv W Fk Pinto Cr Chronic criterion = 12.7 ug/L Acute criterion = 19.7 ug/L	25.1	21.2	26.4	27.0	27.4
11. West Fork Pinto Creek Chronic criterion = 10.5 ug/L Acute criterion = 16.0 ug/L	7.4	4.4	6.3	6.4	5.3
12. PC-300 Chronic criterion = 29.3 ug/L Acute criterion = 49.6 ug/L	22.6	18.7	24.8	25.9	26.9
13. Basin Exit Chronic criterion = 16.6 ug/L Acute criterion = 26.4 ug/L	22.4	16.9	24.6	25.5	26.7

TABLE 5
Model Predictions of Dissolved Copper Load (kg/d)
for Background/Ambient Model Scenario with Mining Sources Set to Ten Times Background

Location	Storm Event				
	2-yr, 1-hr	2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
1. Pinto Cr above H.R. Mine	0.379	0.080	0.682	1.40	2.57
2. Pinto Creek above Gibson	1.33	0.228	2.19	4.59	8.58
3. Gibson Tributary	0.302	0.064	0.525	1.06	1.83
4. Unnamed Tributary #2	1.17	0.18	1.82	3.73	6.45
5. Five Point Mountain Tributary	1.17	0.178	1.82	3.73	6.45
6. PC-100	2.96	0.427	4.53	9.75	17.63
7. Below Cactus Breccia	5.98	0.974	9.15	18.6	32.3
8. Haunted Canyon	4.22	0.749	6.05	11.8	20.0
9. PC-200	13.1	2.18	19.4	38.6	66.2
10. Pinto Cr abv W Fk Pinto Cr	7.92	1.22	10.4	20.2	33.2
11. West Fork Pinto Creek	0.518	0.057	0.313	0.458	0.222
12. PC-300	8.99	1.35	11.1	21.2	33.7
13. Basin Exit	8.85	1.14	10.4	20.0	32.2

TABLE 6
Model Predictions of Dissolved Copper Load (kg/d)
for Background/Ambient Model Scenario with Mining Sources Set to Background

Location	Storm Event				
	2-yr, 1-hr	2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
1. Pinto Cr above H.R. Mine	0.379	0.080	0.682	1.40	2.57
2. Pinto Creek above Gibson	1.30	0.223	2.14	4.48	8.38
3. Gibson Tributary	0.198	0.042	0.342	0.69	1.20
4. Unnamed Tributary #2	1.17	0.18	1.82	3.73	6.45
5. Five Point Mountain Tributary	1.17	0.178	1.82	3.73	6.45
6. PC-100	2.86	0.403	4.33	9.34	16.92
7. Below Cactus Breccia	5.68	0.921	8.68	17.7	30.7
8. Haunted Canyon	4.22	0.749	6.05	11.8	20.0
9. PC-200	12.0	1.98	17.7	35.3	60.5
10. Pinto Cr abv W Fk Pinto Cr	6.68	1.03	9.1	18.0	30.1
11. West Fork Pinto Creek	0.518	0.057	0.313	0.458	0.222
12. PC-300	7.75	1.16	9.8	18.9	30.6
13. Basin Exit	7.62	0.98	9.2	17.9	29.2

TABLE 7
Model Predictions of Dissolved Copper Load (kg/d)
for Current Conditions Model Scenario

Location	Storm Event				
	2-yr, 1-hr	2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
1. Pinto Cr above H.R. Mine	0.379	0.080	0.682	1.40	2.57
2. Pinto Creek above Gibson	1.80	0.288	2.90	6.09	11.4
3. Gibson Tributary	44.3	8.78	75.0	151.68	265
4. Unnamed Tributary #2	3.59	0.548	5.6	11.4	19.8
5. Five Point Mountain Tributary	3.59	0.548	5.6	11.4	19.8
6. PC-100	47.0	8.55	78.3	160	281
7. Below Cactus Breccia	25.8	4.41	42.0	85.5	149.5
8. Haunted Canyon	4.22	0.749	6.05	11.8	20.0
9. PC-200	32.4	5.38	51.2	103.8	180.6
10. Pinto Cr abv W Fk Pinto Cr	17.0	2.65	25.8	51.9	89.4
11. West Fork Pinto Creek	0.518	0.057	0.313	0.458	0.222
12. PC-300	18.1	2.79	26.4	52.8	89.9
13. Basin Exit	17.7	2.31	25.0	50.2	86.1

TABLE 8
Model Predictions of Dissolved Copper Load (kg/d) from Specific Sources for Background/Ambient Model Scenario with Mining Sources Set to Ten Times Background

Location	Storm Event				
	2-yr, 1-hr	2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
1. Ellis Mine	1.560E-03	3.120E-04	2.744E-03	5.714E-03	1.054E-02
2. Henderson Ranch Mine	3.530E-02	5.479E-03	5.591E-02	1.177E-01	2.213E-01
3. Gibson Mine	1.171E-01	2.339E-02	1.986E-01	4.031E-01	7.023E-01
4. Bronx Mine	4.582E-02	6.853E-03	6.945E-02	1.440E-01	2.502E-01
5. Old Highway 60 Mine	4.582E-02	6.853E-03	6.945E-02	1.440E-01	2.502E-01
6. BHP005	1.200E-02	1.200E-02	1.200E-02	1.200E-02	1.200E-02
7. Yo Tambien Mine	5.093E-02	9.091E-03	7.520E-02	1.494E-01	2.542E-01

TABLE 9
Model Predictions of Dissolved Copper Load (kg/d) from Specific Sources for Background/Ambient Model Scenario with Mining Sources Set to Background

Location	Storm Event				
	2-yr, 1-hr	2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
1. Ellis Mine	1.560E-03	3.120E-04	2.744E-03	5.714E-03	1.054E-02
2. Henderson Ranch Mine	3.530E-03	5.479E-04	5.591E-03	1.177E-02	2.213E-02
3. Gibson Mine	1.171E-02	2.339E-03	1.986E-02	4.031E-02	7.023E-02
4. Bronx Mine	4.582E-03	6.853E-04	6.945E-03	1.440E-02	2.502E-02
5. Old Highway 60 Mine	4.582E-03	6.853E-04	6.945E-03	1.440E-02	2.502E-02
6. BHP005	1.200E-02	1.200E-02	1.200E-02	1.200E-02	1.200E-02
7. Yo Tambien Mine	5.094E-03	9.091E-04	7.520E-03	1.494E-02	2.542E-02

TABLE 10
Model Predictions of Dissolved Copper Load (kg/d) from Specific Sources
for Background/Ambient Model Scenario with Mining Sources Set to Ten Times Background

Location	Storm Event				
	2-yr, 1-hr	2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
1. Ellis Mine	1.560E-03	3.120E-04	2.744E-03	5.714E-03	1.054E-02
2. Henderson Ranch Mine	4.607E-01	5.711E-02	6.859E-01	1.457E+00	2.779E+00
3. Gibson Mine	4.410E+01	8.261E+00	7.339E+01	1.493E+02	2.617E+02
4. Bronx Mine	1.265E+00	1.897E-01	1.923E+00	3.981E+00	6.922E+00
5. Old Highway 60 Mine	1.265E+00	1.897E-01	1.923E+00	3.981E+00	6.922E+00
6. BHP005	1.200E-02	1.200E-02	1.200E-02	1.200E-02	1.200E-02
7. Yo Tambien Mine	1.317E-02	1.734E-03	1.766E-02	3.544E-02	6.132E-02