Appendix C

Air Risk Calculations and Summary Tables

Appendix C – Air Risk Calculations and Summary Tables

Summary Statistics

- **Hayden Properties**
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Risk Calculations

- **Hayden Properties**
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Summary Statistics

Hayden Properties

Winkelman Properties

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Baseline Human Health Risk Assessment

Asarco LLC Hayden Plant Site, Hayden, Arizona

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Table C-1
Summary Statistics for Air Monitoring Data in Hayden
Baseline Human Health Risk Assessment
Asarco LLC Hayden Plant Site, Hayden, Arizona

Site	Parameter	Number of Detects	Number of Analyses	Percent Detects	Units	Minimum Detected Value	Maximum Detected Value	Minimum DL for Non-detects	Maximum DL for Non-detects	Location of Maximum Detected Concentration	Arithmetic Mean Value	Standard Deviation	Exposure Point Concentration	EPC Basis	Exposure Point Concentration (may be Max)	EPC Basis (may be Max)
Hayden	Aluminum	55	57	96	ug/m3	0.132	4.16	0.0075	0.0084	MY-060107	1.19	0.751	1.36	95% KM (t) UCL	1.36	95% KM (t) UCL
Hayden	Antimony	4	57	7	ug/m3	0.0032	0.012	0.003	0.0207	MY-091107	0.00455	0.00206	0.00417	95% KM (t) UCL	0.00417	95% KM (t) UCL
Hayden	Arsenic	49	57	86	ug/m3	0.0034	0.189	0.0009	0.0093	MY-091107	0.0239	0.0435	0.0493	95% KM (Chebyshev) UCL	0.0493	95% KM (Chebyshev) UCL
Hayden	Barium	23	57	40	ug/m3	0.01	0.0599	0.0042	0.0222	MY-112106	0.0137	0.0143	0.0194	95% KM (t) UCL	0.0194	95% KM (t) UCL
Hayden	Bismuth	10	10	100	ug/m3	0.0034	0.262	NA	NA	MY-091107	0.0732	0.107	0.454	99% Chebyshev (MVUE) UCL	0.262	Maximum Result
Hayden	Bromine	34	57	60	ug/m3	0.0012	0.0076	0.0006	0.006	MY-051407	0.00211	0.00164	0.00261	95% KM (t) UCL	0.00261	95% KM (t) UCL
Hayden	Cadmium	5	57	9	ug/m3	0.0108	0.0351	0.0021	0.0144	MY-083007	0.00453	0.00623	0.0128	95% KM (t) UCL	0.0128	95% KM (t) UCL
Hayden	Calcium	55	57	96	ug/m3	0.0093	3.23	0.0015	0.762	MY-060107	0.961	0.634	1.11	95% KM (BCA) UCL	1.11	95% KM (BCA) UCL
Hayden	Chlorine	34	57	60	ug/m3	0.0084	0.874	0.0045	0.0282	MY-060707	0.0845	0.143	0.168	95% KM (Chebyshev) UCL	0.168	95% KM (Chebyshev) UCL
Hayden	Chromium	27	57	47	ug/m3	0.0013	0.0072	0.0009	0.0021	MY-060107	0.00175	0.00162	0.0024	95% KM (t) UCL	0.0024	95% KM (t) UCL
Hayden	Copper	56	57	98	ug/m3	0.0047	4	0.0018	0.0018	MY-112106	0.724	1.03	1.32	95% KM (Chebyshev) UCL	1.32	95% KM (Chebyshev) UCL
Hayden	Iron	56	57	98	ug/m3	0.0126	3.75	0.0021	0.0021	MY-060107	1.23	0.767	1.41	95% KM (t) UCL	1.41	95% KM (t) UCL
Hayden	Lead	55	57	96	ug/m3	0.0033	0.836	0.0024	0.0027	MY-091107	0.0853	0.169	0.183	95% KM (Chebyshev) UCL	0.183	95% KM (Chebyshev) UCL
Hayden	Magnesium	48	57	84	ug/m3	0.0371	0.742	0.0132	0.096	MY-060107	0.188	0.152	0.232	95% KM (BCA) UCL	0.232	95% KM (BCA) UCL
Hayden	Manganese	52	54	96	ug/m3	0.0015	0.0487	0.0012	0.0015	MY-060107	0.0172	0.0106	0.0197	95% KM (BCA) UCL	0.0197	95% KM (BCA) UCL
Hayden	Molybdenum	45	57	79	ug/m3	0.0028	0.0804	0.0021	0.0036	MY-091107	0.0136	0.0186	0.018	95% KM (BCA) UCL	0.018	95% KM (BCA) UCL
Hayden	Nickel	1	57	2	ug/m3	0.0019	0.0019	0.0018	0.0066	MY-012007	0.00121	0.000339	0.0014	Too Few Unique Detected Values *	0.0014	Too Few Unique Detected Values *
Hayden	PM10	58	58	100	ug/m3	0.46	91.5	NA	NA	MY-060107	37.7	18.1	41.7	95% Student's-t UCL	41.7	95% Student's-t UCL
Hayden	Potassium	56	57	98	ug/m3	0.0036	1.76	0.0021	0.0021	MY-060107	0.54	0.325	0.612	95% KM (t) UCL	0.612	95% KM (t) UCL
Hayden	Rubidium	34	57	60	ug/m3	0.0011	0.0095	0.0009	0.0033	MY-060107	0.00229	0.00194	0.00287	95% KM (t) UCL	0.00287	95% KM (t) UCL
Hayden	Selenium	38	57	67	ug/m3	0.0014	0.122	0.0006	0.0012	MY-010807	0.0107	0.0248	0.0253	95% KM (Chebyshev) UCL	0.0253	95% KM (Chebyshev) UCL
Hayden	Silicon	56	57	98	ug/m3	0.0235	9.26	0.0051	0.0051	MY-060107	2.93	1.74	3.31	95% KM (t) UCL	3.31	95% KM (t) UCL
Hayden	Silver	2	57	4	ug/m3	0.0147	0.0175	0.0021	0.0144	MY-083007	0.00333	0.00263	0.0149	95% KM (t) UCL	0.0149	95% KM (t) UCL
Hayden	Sodium	13	57	23	ug/m3	0.123	0.532	0.0261	0.831	MY-070107	0.141	0.137	0.198	95% KM (t) UCL	0.198	95% KM (t) UCL
Hayden	Strontium	50	57	88	ug/m3	0.0019	0.0157	0.0012	0.0015	MY-060107	0.00531	0.00345	0.00626	95% KM (BCA) UCL	0.00626	95% KM (BCA) UCL
Hayden	Sulfur	55	57	96	ug/m3	0.147	2.62	0.0027	0.003	MY-091107	0.841	0.547	0.957	95% KM (BCA) UCL	0.957	95% KM (BCA) UCL
Hayden	Tin	5	57	9	ug/m3	0.0079	0.0123	0.0024	0.0198	MY-010807	0.00443	0.00214	0.00828	95% KM (t) UCL	0.00828	95% KM (t) UCL
Hayden	Titanium	56	57	98	ug/m3	0.0014	0.346	0.0009	0.0009	MY-032107	0.0968	0.0628	0.111	95% KM (BCA) UCL	0.111	95% KM (BCA) UCL
Hayden	Vanadium	3	57	5	ug/m3	0.001	0.0149	0.0009	0.0144	MY-090507	0.00241	0.00218	0.00191	95% KM (t) UCL	0.00191	95% KM (t) UCL
Hayden	Yttrium	5	57	9	ug/m3	0.0009	0.0028	0.0009	0.006	MY-060107	0.00103	0.000544	0.0012	95% KM (t) UCL	0.0012	95% KM (t) UCL
Hayden	Zinc	53	57	93	ug/m3	0.0017	0.655	0.0015	0.0201	MY-091107	0.0721	0.132	0.148	95% KM (Chebyshev) UCL	0.148	95% KM (Chebyshev) UCL
Hayden	Zirconium	37	57	65	ug/m3	0.0018	0.0103	0.0015	0.006	MY-060107	0.0028	0.00186	0.00348	95% KM (Percentile Bootstrap) UCL	0.00348	95% KM (Percentile Bootstrap) UCL

* When the EPC Basis reads "Two or Fewer Unique Detected Values", ProUCL Version 4 does not offer a 95% UCL. A Chebychev UCL was calculated using ND proxy values of 1/2 the detection limit. An alternative is to use the maximum detect for these cases.

Table C-2
Summary Statistics for Air Monitoring Data in Winkelman
Baseline Human Health Risk Assessment
Asarco LLC Hayden Plant Site, Hayden, Arizona

Site	Parameter	Number of Detects	Number of Analyses	Percent Detects	Units	Minimum Detected Value	Maximum Detected Value	Minimum DL for Non-detects	Maximum DL for Non-detects	Location of Maximum Detected Concentration	Arithmetic Mean Value	Standard Deviation	Exposure Point Concentration	EPC Basis	Exposure Point Concentration (may be Max)	EPC Basis (may be Max)
Winkelman	Aluminum	54	55	98	ug/m3	0.0505	4.09	0.0066	0.0066	HS-032707	0.637	0.646	1.02	95% KM (Chebyshev) UCL	1.02	95% KM (Chebyshev) UCL
Winkelman	Antimony	3	55	5	ug/m3	0.0027	0.0032	0.0024	0.0048	HS-081207	0.00155	0.000479	0.00276	95% KM (t) UCL	0.00276	95% KM (t) UCL
Winkelman	Arsenic	39	55	71	ug/m3	0.0023	0.0282	0.0009	0.0039	HS-050807	0.00796	0.00759	0.01	95% KM (Percentile Bootstrap) UCL	0.01	95% KM (Percentile Bootstrap) UC L
Winkelman	Barium	23	55	42	ug/m3	0.008	0.0452	0.0036	0.0111	HS-032707	0.00795	0.00786	0.0123	95% KM (t) UCL	0.0123	95% KM (t) UCL
Winkelman	Bismuth	7	7	100	ug/m3	0.0026	0.0131	NA	NA	HS-082407	0.00654	0.00388	0.0094	95% Student's-t UCL	0.0094	95% Student's-t UCL
Winkelman	Bromine	44	55	80	ug/m3	0.0006	0.0083	0.0009	0.0015	HS-040807	0.00222	0.00161	0.00261	95% KM (BCA) UCL	0.00261	95% KM (BCA) UCL
Winkelman	Cadmium	6	55	11	ug/m3	0.0022	0.0029	0.0015	0.0033	HS-062507	0.00121	0.000517	0.00227	95% KM (t) UCL	0.00227	95% KM (t) UCL
Winkelman	Calcium	54	55	98	ug/m3	0.0724	3.12	0.0015	0.0015	HS-032707	0.549	0.48	0.831	95% KM (Chebyshev) UCL	0.831	95% KM (Chebyshev) UCL
Winkelman	Chlorine	26	55	47	ug/m3	0.0132	0.783	0.0042	0.0168	HS-060707	0.0793	0.135	0.114	95% KM (t) UCL	0.114	95% KM (t) UCL
Winkelman	Chromium	13	55	24	ug/m3	0.0013	0.0056	0.0009	0.0015	HS-032707	0.000945	0.000929	0.00169	95% KM (t) UCL	0.00169	95% KM (t) UCL
Winkelman	Copper	54	54	100	ug/m3	0.0024	1.3	NA	NA	HS-050807	0.288	0.267	0.363	95% Approximate Gamma UCL	0.363	95% Approximate Gamma UCL
Winkelman	Iron	55	55	100	ug/m3	0.0024	3.23	NA	NA	HS-032707	0.573	0.494	0.696	95% Approximate Gamma UCL	0.696	95% Approximate Gamma UCL
Winkelman	Lead	46	55	84	ug/m3	0.003	0.083	0.0024	0.0033	HS-062507	0.0224	0.0211	0.0281	95% KM (BCA) UCL	0.0281	95% KM (BCA) UCL
Winkelman	Magnesium	35	55	64	ug/m3	0.0468	0.542	0.0123	0.0834	HS-032707	0.097	0.109	0.135	95% KM (BCA) UCL	0.135	95% KM (BCA) UCL
Winkelman	Manganese	49	55	89	ug/m3	0.0016	0.0544	0.0012	0.0015	HS-032707	0.00908	0.00933	0.0118	95% KM (BCA) UCL	0.0118	95% KM (BCA) UCL
Winkelman	Molybdenum	18	55	33	ug/m3	0.0033	0.0197	0.0012	0.0033	HS-050807	0.00324	0.00366	0.00527	95% KM (t) UCL	0.00527	95% KM (t) UCL
Winkelman	PM10	55	55	100	ug/m3	1.53	82.4	NA	NA	HS-032707	20.2	13.4	23.2	95% Student's-t UCL	23.2	95% Student's-t UCL
Winkelman	Potassium	55	55	100	ug/m3	0.0024	1.82	NA	NA	HS-032707	0.279	0.268	0.339	95% Approximate Gamma UCL	0.339	95% Approximate Gamma UCL
Winkelman	Rubidium	15	55	27	ug/m3	0.0007	0.0084	0.0006	0.0015	HS-032707	0.00104	0.00122	0.00142	95% KM (t) UCL	0.00142	95% KM (t) UCL
Winkelman	Selenium	30	55	55	ug/m3	0.0009	0.0079	0.0006	0.0012	HS-070107	0.00209	0.00191	0.00267	95% KM (t) UCL	0.00267	95% KM (t) UCL
Winkelman	Silicon	54	55	98	ug/m3	0.168	10.4	0.0051	0.0051	HS-032707	1.6	1.58	2.54	95% KM (Chebyshev) UCL	2.54	95% KM (Chebyshev) UCL
Winkelman	Silver	4	55	7	ug/m3	0.0019	0.0026	0.0015	0.0033	HS-082407	0.0011	0.000363	0.00195	95% KM (t) UCL	0.00195	95% KM (t) UCL
Winkelman	Sodium	18	55	33	ug/m3	0.181	0.655	0.0255	0.586	HS-060707	0.136	0.151	0.247	95% KM (t) UCL	0.247	95% KM (t) UCL
Winkelman	Strontium	44	55	80	ug/m3	0.001	0.0211	0.0009	0.0018	HS-032707	0.00373	0.00336	0.00476	95% KM (BCA) UCL	0.00476	95% KM (BCA) UCL
Winkelman	Sulfur	54	55	98	ug/m3	0.0924	1.53	0.0018	0.0018	HS-081807	0.493	0.263	0.553	95% KM (t) UCL	0.553	95% KM (t) UCL
Winkelman	Tin	9	55	16	ug/m3	0.0032	0.0116	0.0024	0.0048	HS-020707	0.00263	0.00259	0.00444	95% KM (t) UCL	0.00444	95% KM (t) UCL
Winkelman	Titanium	54	55	98	ug/m3	0.0045	0.333	0.0009	0.0009	HS-032707	0.0461	0.0476	0.0741	95% KM (Chebyshev) UCL	0.0741	95% KM (Chebyshev) UCL
Winkelman	Vanadium	2	55	4	ug/m3	0.0028	0.0038	0.0009	0.0141	HS-091707	0.00123	0.00101	0.00287	95% KM (t) UCL	0.00287	95% KM (t) UCL
Winkelman	Yttrium	2	55	4	ug/m3	0.0009	0.0027	0.0006	0.0021	HS-032707	0.000799	0.000322	0.00101	95% KM (t) UCL	0.00101	95% KM (t) UCL
Winkelman	Zinc	51	54	94	ug/m3	0.0018	0.0901	0.0015	0.0021	HS-070107	0.0203	0.019	0.0315	95% KM (Chebyshev) UCL	0.0315	95% KM (Chebyshev) UCL
Winkelman	Zirconium	15	55	27	ug/m3	0.0011	0.0096	0.0009	0.0027	HS-032707	0.00149	0.00134	0.00199	95% KM (t) UCL	0.00199	95% KM (t) UCL

* When the EPC Basis reads "Two or Fewer Unique Detected Values", ProUCL Version 4 does not offer a 95% UCL. A Chebychev UCL was calculated using ND proxy values of 1/2 the detection limit. An alternative is to use the maximum detect for these cases.

Risk Calculations

Hayden Properties
Winkelman Properties

Table C-3
Risk Calculation Worksheet for Air - Carcinogenic Effects - Residential Exposure Scenario - Hayden - Hayden Maintenance Yard
Baseline Human Health Risk Assessment
Asarco LLC Hayden Plant Site, Hayden, Arizona

Exposure Scenario Information		
	Exposure Scenario:	Residential
	Scenario Timeframe:	Chronic
	Exposure Medium:	Air
	Exposure Point:	OnSite
	Receptor Population:	Adult/Child Resident
	Receptor Age:	Adult/Child

Exposure Scenario/Exposure Area Description

Site Risks

Hayden - Hayden Maintenance Yard

Exposure Parameter	Variable		Adult Value	Child Value	Units
Exposure Frequency	EF		350	350	day/yr
Exposure Duration	ED		24	6	yr
Inhalation Rate	InhR		20	10	m^3/day
Body Weight	BW		70	15	kg
Averaging Time for carcinogens	ATc		70	70	yr
Conversion Factor (yr to day)	CF		2.74E-03	2.74E-03	yrs/day
Conversion Factor (ug to mg)	CF		1.00E+03	1.00E+03	ug/mg

Risk Calculations

		Exposure Route = Inhalation		
Chemical of Potential Concern	**EPC Value [ug/m^3]**	**Chronic Daily Intake [mg/kg/day]**	**Cancer Slope Factor, SF [mg/kg/day]$^{-1}$**	**Cancer Risk [-]**
Adult Resident				
Arsenic	4.93E-02	4.63E-06	1.51E+01	6.97E-05
Cadmium	1.28E-02	1.20E-06	6.30E+00	7.57E-06
Chromium	2.40E-03	2.25E-07	4.20E+01	9.47E-06
Child Resident				
Arsenic	4.93E-02	2.70E-06	1.51E+01	4.07E-05
Cadmium	1.28E-02	7.01E-07	6.30E+00	4.42E-06
Chromium	2.40E-03	1.32E-07	4.20E+01	5.52E-06
Total Adult Resident				8.7E-05
Total Child Resident				5.1E-05
Total Adult/Child Resident				1.4E-04

Notes:
NA = no data; this toxicity value is not available in the standard U.S. EPA toxicity value databases.
RME = reasonable maximum exposure.
EPC = exposure point concentration.

Table C-4
Summary of Inhalation Cancer Risks from Exposure to Air - Hayden - Hayden Maintenance Yard
Baseline Human Health Risk Assessment
ASARCO LLC Hayden Plant Site, Hayden, Arizona

Property	Receptor	COPC	EPC Value (ug/m^3)	Carcinogenic Risk
Hayden Maintenance Yard	**Adult Resident**	Arsenic	4.93E-02	6.97E-05
		Cadmium	1.28E-02	7.57E-06
		Chromium	2.40E-03	9.47E-06
		Total		8.7E-05
	Child Resident	Arsenic	4.93E-02	4.07E-05
		Cadmium	1.28E-02	4.42E-06
		Chromium	2.40E-03	5.52E-06
				5.1E-05
	Adult/Child Resident	Arsenic	4.93E-02	1.10E-04
		Cadmium	1.28E-02	1.20E-05
		Chromium	2.40E-03	1.50E-05
		Total		1.4E-04

Notes:
NA = Not applicable

Table C-5
Hayden Air Monitoring Data Residential Cancer Risks - Hayden Maintenance Yard
Baseline Human Health Risk Assessment
Asarco LLC Hayden Plant Site, Hayden, Arizona

Chemical	EPC Value (ug/m^3)	Adult plus Child Cancer Risks
Arsenic	4.9E-02	1.1E-04
Cadmium	1.3E-02	1.2E-05
Chromium	2.4E-03	1.5E-05
Total		1.4E-04

Table C-6
Risk Calculation Worksheet for Air - Carcinogenic Effects - Residential Exposure Scenario - Winkelman - Winkelman/Hayden High School
Baseline Human Health Risk Assessment
Asarco LLC Hayden Plant Site, Hayden, Arizona

Exposure Scenario Information		
	Exposure Scenario:	Residential
	Scenario Timeframe:	Chronic
	Exposure Medium:	Air
	Exposure Point:	OnSite
	Receptor Population:	Adult/Child Resident
	Receptor Age:	Adult/Child

Exposure Scenario/Exposure Area Description

Site Risks

Winkelman - Winkelman/Hayden High School

Exposure Parameter	Variable		Adult Value	Child Value	Units
Exposure Frequency	EF		350	350	day/yr
Exposure Duration	ED		24	6	yr
Inhalation Rate	InhR		20	10	m^3/day
Body Weight	BW		70	15	kg
Averaging Time for carcinogens	ATc		70	70	yr
Conversion Factor (yr to day)	CF		2.74E-03	2.74E-03	yrs/day
Conversion Factor (ug to mg)	CF		1.00E+03	1.00E+03	ug/mg

Risk Calculations

Exposure Route = Inhalation

Chemical of Potential Concern	EPC Value [ug/m^3]	Chronic Daily Intake [mg/kg/day]	Cancer Slope Factor, SF [mg/kg/day]$^{-1}$	Cancer Risk [-]
Adult Resident				
Arsenic	1.00E-02	9.39E-07	1.51E+01	1.41E-05
Cadmium	2.27E-03	2.13E-07	6.30E+00	1.34E-06
Chromium	1.69E-03	1.59E-07	4.20E+01	6.67E-06
Child Resident				
Arsenic	1.00E-02	5.48E-07	1.51E+01	8.25E-06
Cadmium	2.27E-03	1.24E-07	6.30E+00	7.84E-07
Chromium	1.69E-03	9.26E-08	4.20E+01	3.89E-06
Total Adult Resident				2.2E-05
Total Child Resident				1.3E-05
Total Adult/Child Resident				3.5E-05

Notes:
NA = no data; this toxicity value is not available in the standard U.S. EPA toxicity value databases.
RME = reasonable maximum exposure.
EPC = exposure point concentration.

Table C-7
Summary of Inhalation Cancer Risks from Exposure to Air - Winkelman - Winkelman/Hayden High School
Baseline Human Health Risk Assessment
Asarco LLC Hayden Plant Site, Hayden, Arizona

Property	Receptor	COPC	EPC Value (ug/m^3)	Carcinogenic Risk
Winkelman/Hayden High School	**Adult Resident**	Arsenic	1.00E-02	1.41E-05
		Cadmium	2.27E-03	1.34E-06
		Chromium	1.69E-03	6.67E-06
		Total		2.2E-05
	Child Resident	Arsenic	1.00E-02	8.25E-06
		Cadmium	2.27E-03	7.84E-07
		Chromium	1.69E-03	3.89E-06
		Total		1.3E-05
	Adult/Child Resident	Arsenic	1.00E-02	2.24E-05
		Cadmium	2.27E-03	2.13E-06
		Chromium	1.69E-03	1.06E-05
		Total		3.5E-05

Notes:
NA = Not applicable

Table C-8
Winkelman Air Monitoring Data Residential Cancer Risks - Winkelman/Hayden High School
Baseline Human Health Risk Assessment
Asarco LLC Hayden Plant Site, Hayden, Arizona

Chemical	EPC Value (ug/m^3)	Adult plus Child Cancer Risks
Arsenic	1.0E-02	2.2E-05
Cadmium	2.3E-03	2.1E-06
Chromium	1.7E-03	1.1E-05
Total		3.5E-05