Lead Contamination in Urban Surface Waters

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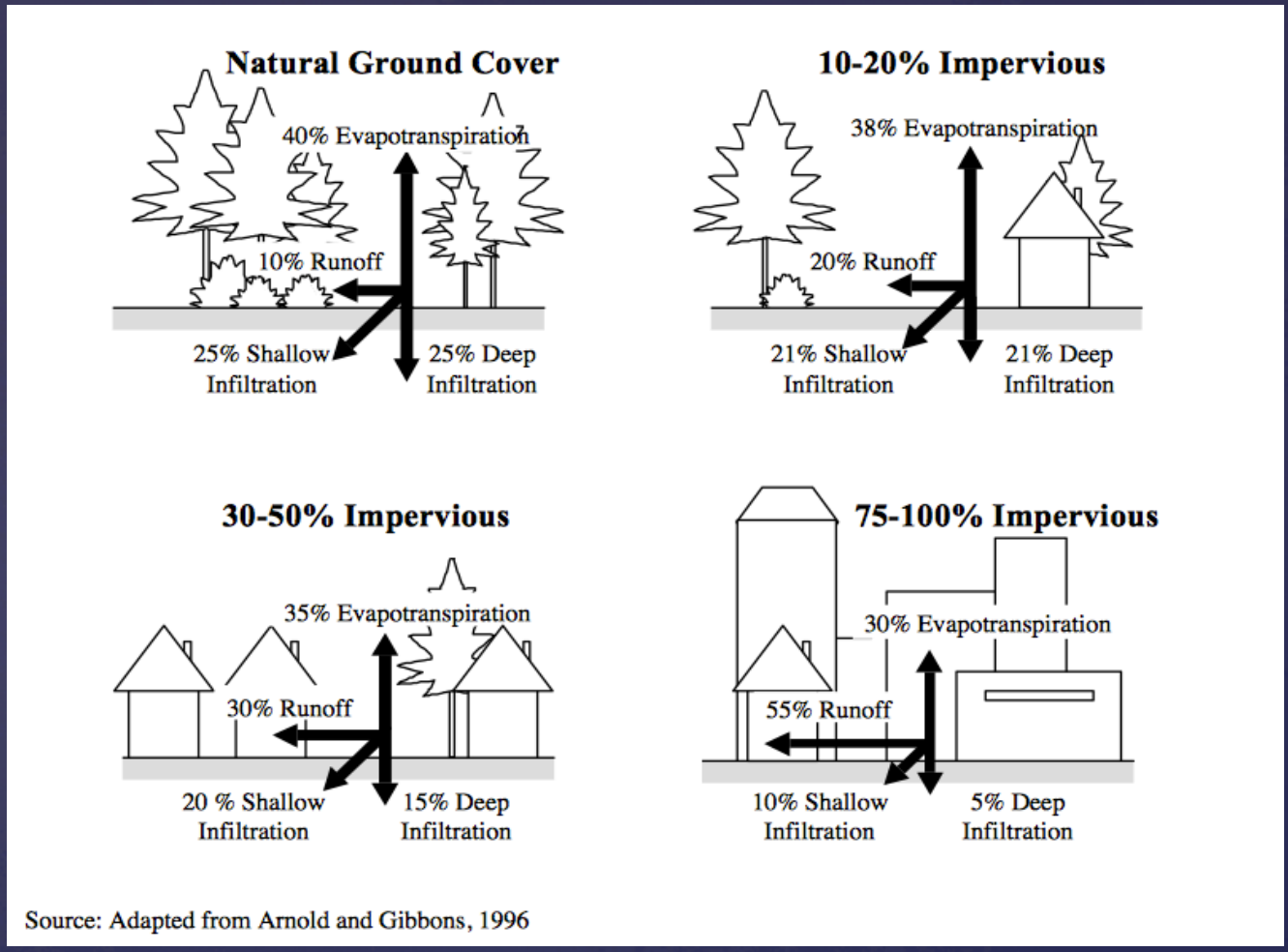


Source: Adapted from Arnold and Gibbons, 1996

Infiltration and Runoff

Water Quality Factors

- Different Factors such as soil types, slopes, land use, and imperviousness can greatly affect the quality of runoff in an urban area
- The original paper focused on how the imperviousness nature of urban areas increases the amounts of Lead, Copper, and Zinc in Surface waters after a storm water runoff event

Test Site: Snake River & Idaho Falls

Sample code number	99WA140	00WA155	00WA156	00WA157
Description	Tributary to Columbine Creek	Columbine Creek west headwaters	Columbine Creek east fork	Columbine Creek east fork
Date collected	9/22/1999	9/17/2000	9/17/2000	9/17/2000
Temperature (°C)	---[1]	7.3	11.8	11.3
Density (g/mL) at 20°C	1.0024	0.99833	0.99835	0.99835
pH	2.70	6.68	6.32	3.89
Spec Cond (µS/cm) field / lab	--- / 820	58 / 59	136 / ---	227 / 241
Eh (V)	---[1]	0.477	0.294	0.605
D.O. (mg/L)	---[1]	8.11	7.8	7.8
Constituent (mg/L)				
Ca	6.1	4.4	8.9	10
Mg	2.9	2.3	6.8	7.5
Sr	0.090	0.051	0.079	0.097
Ba	0.026	0.021	0.019	0.025
Na	4.5	2.2	4.3	5.3
K	4.0	1.4	1.6	2.3
Li	0.002	<0.008	<0.008	<0.008
SO_4	180	8.5	35	89
H_2S	---[1]	<0.001	---	---
Alkalinity (as HCO_3)	---	20.2	27.7	---

PHREEQC output tributaries to Snake River, WY

Pb	4.827e-09					
	PbCO3	3.873e-09	3.874e-09	-8.412	-8.412	0.000
	PbOH+	4.864e-10	4.712e-10	-9.313	-9.327	-0.014
	Pb+2	3.531e-10	3.110e-10	-9.452	-9.507	-0.055
	PbHCO3+	7.840e-11	7.595e-11	-10.106	-10.119	-0.014
	Pb(OH)2	1.424e-11	1.425e-11	-10.846	-10.846	0.000
	PbSO4	1.330e-11	1.330e-11	-10.876	-10.876	0.000
	Pb(CO3)2-2	7.921e-12	6.975e-12	-11.101	-11.156	-0.055
	PbCl+	2.628e-13	2.545e-13	-12.580	-12.594	-0.014
	Pb(OH)3-	1.312e-14	1.271e-14	-13.882	-13.896	-0.014
	Pb(SO4)2-2	6.033e-15	5.312e-15	-14.219	-14.275	-0.055
	PbCl2	1.879e-17	1.880e-17	-16.726	-16.726	0.000
	Pb2OH+3	4.367e-18	3.280e-18	-17.360	-17.484	-0.124
	Pb(OH)4-2	2.570e-18	2.263e-18	-17.590	-17.645	-0.055
	PbCl3-	4.499e-22	4.359e-22	-21.347	-21.361	-0.014
	PbCl4-2	6.720e-27	5.917e-27	-26.173	-26.228	-0.055
	PbNO3+	9.263e-36	8.973e-36	-35.033	-35.047	-0.014
S(-2)	0.000e+00					

Initial Results

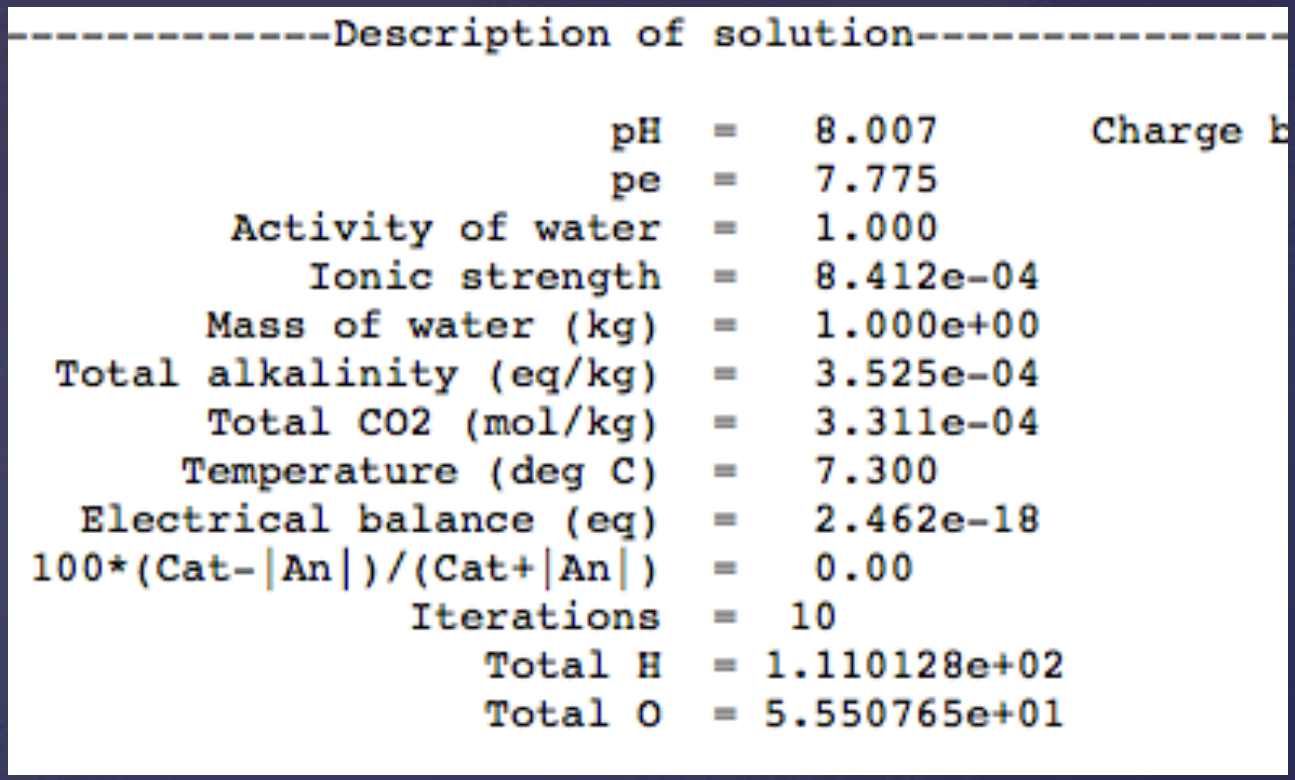
- The waters typically feature low pH's
- Feature an alkalinity around 20
- Minerals containing Lead Saturation Index is Low
- What happens when you introduce pollutants, specifically Lead, that are typical to the amounts found in storm water runoff in urban areas?

NURP

- The Nationwide Urban Runoff Program
- NURP discovered the average urban pollution amounts for Lead, Copper, and Zinc, as well as other water quality factors
- These amounts found in major rivers and lakes at test sites around the nation close to urban environments

Pollutant	Units	Residential		Mixed		Commercial	
		Median	COV	Median	COV	Median	COV
BOD	mg/l	10	0.41	7.8	0.52	9.3	0.31
COD	mg/l	73	0.55	65	0.58	57	0.39
TSS	mg/l	101	0.96	67	1.14	69	0.85
Total Lead	µg/l	144	0.75	114	1.35	104	0.68
Total Copper	µg/l	33	0.99	27	1.32	29	0.81
Total Zinc	µg/l	135	0.84	154	0.78	226	1.07
Total Kjeldahl Nitrogen	µg/l	1900	0.73	1288	0.50	1179	0.43
Nitrate + Nitrite	µg/l	736	0.83	558	0.67	572	0.48
Total Phosphorus	µg/l	383	0.69	263	0.75	201	0.67
Soluble Phosphorus	µg/l	143	0.46	56	0.75	80	0.71

COV: Coefficient of Variation



Adding Urban Runoff Pollution Values to the Snake River

Pb		5.502e-07				
	PbCO3	4.510e-07	4.511e-07	-6.346	-6.346	0.000
	PbOH+	5.635e-08	5.458e-08	-7.249	-7.263	-0.014
	Pb+2	3.130e-08	2.756e-08	-7.504	-7.560	-0.055
	PbHCO3+	6.985e-09	6.766e-09	-8.156	-8.170	-0.014
	Pb(OH)2	2.157e-09	2.157e-09	-8.666	-8.666	0.000
	Pb(CO3)2-2	1.213e-09	1.067e-09	-8.916	-8.972	-0.055
	PbSO4	1.178e-09	1.178e-09	-8.929	-8.929	0.000
	PbCl+	2.329e-11	2.255e-11	-10.633	-10.647	-0.014
	Pb(OH)3-	2.598e-12	2.516e-12	-11.585	-11.599	-0.014
	Pb(SO4)2-2	5.341e-13	4.702e-13	-12.272	-12.328	-0.055
	Pb2OH+3	4.486e-14	3.367e-14	-13.348	-13.473	-0.125
	PbCl2	1.665e-15	1.665e-15	-14.779	-14.778	0.000
	Pb(OH)4-2	6.652e-16	5.856e-16	-15.177	-15.232	-0.055
	PbCl3-	3.987e-20	3.862e-20	-19.399	-19.413	-0.014
	PbCl4-2	5.955e-25	5.242e-25	-24.225	-24.281	-0.055
	PbNO3+	4.095e-33	3.967e-33	-32.388	-32.402	-0.014

The Saturation Indexes for Minerals containing Lead is a lot higher

Results

- From the PHREEQ output, the pH jumped from 6.68 to over 8 and the saturation of lead increased, showing that storm water can change the geochemistry of natural rivers and streams in urban environments
- This can lead to Lead contaminated organisms
- However, This change is short term in nature, and can be influenced by a number of factors such as location of testing site at the urban environment, volume of the river, and amount of runoff

Sources

- http://wwwbrr.cr.usgs.gov/projects/GWC_chemtherm/pubs/ofr%2002-382.pdf
- http://water.epa.gov/scitech/wastetech/guide/stormwater/upload/2006_10_31_guide_stormwater_usw_b.pdf