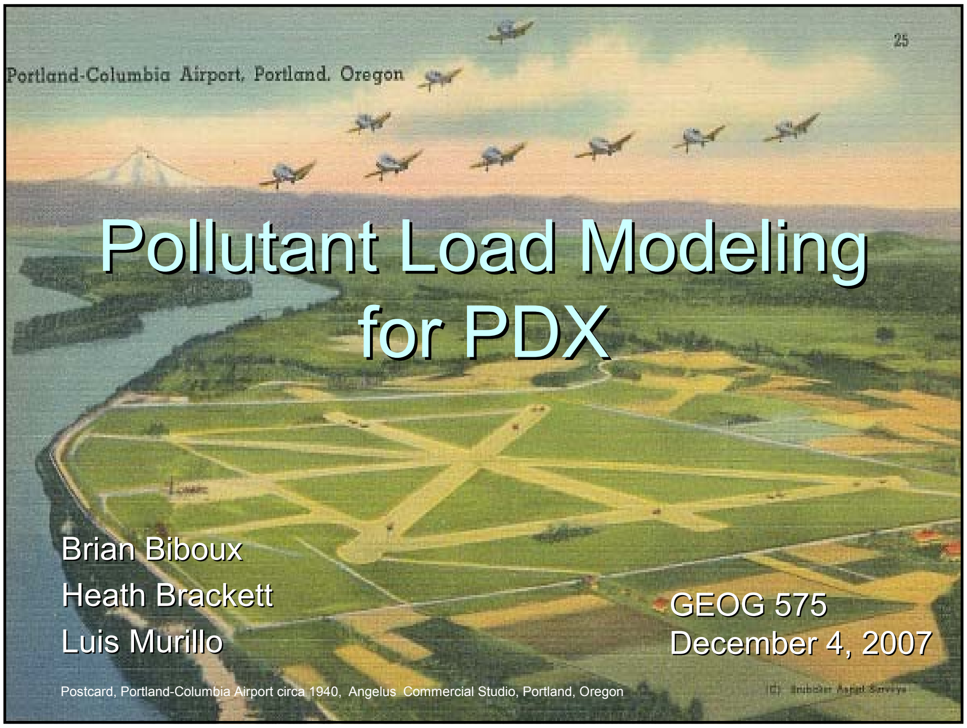

Pollutant Load Modeling for PDX

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Postcard, Portland-Columbia Airport circa 1940, Angelus Commercial Studio, Portland, Oregon

Presentation Overview

- Background
- Objectives and Project Purpose
- Study Area
- Data and Database
- Pollutant Load Model
- Results and Conclusions
- References

Background

- Oregon Department of Environmental Quality (DEQ) regulates stormwater runoff from Port of Portland
- PDX outfalls into Columbia Slough
- Must meet permit requirements (1200-COLS, 1200-Z)
- Monitor levels of 10 pollutants
  - TSS, BOD_5, TKN, NO_3-N, Total P, Ortho P, Oil\Grease, Zn, Pb, Cu
- Altering land use or surface type affects pollutant runoff
- Best Management Practices (BMPs) help reduce pollutant levels
- Expands on Kennedy/Jenks' 2005 study

Objectives

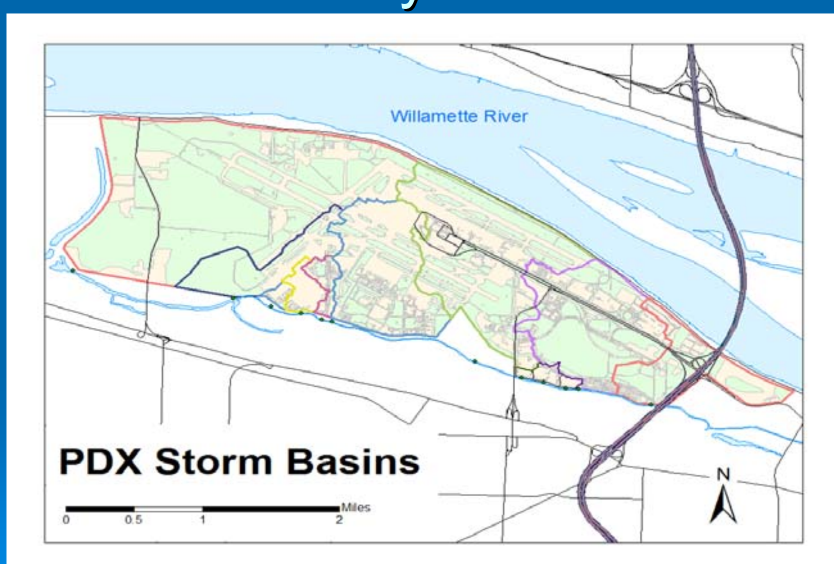
Use GIS to create a pollutant load model for stormwater events

- Create storm system connectivity and flow per storm basin
- Create tables of pollutants, EMCs, BMPs
- Overlay HLUA, surface type, soils layers
- Model pollutant load per storm basin at outfall

Purpose

- Provide Port with a GIS database to manage stormwater pollutants
- Allow for accurate modeling impacts of possible land use changes
- Allow for assessment and future improvement of BMPs

Study Area



Storm System Dataset

Features Classes

- Catch basins, manholes and misc. features
  - Point features serving as stormwater input to pipe system
- Outfalls
  - Point features serving as storm pipe output to slough
- Pipes
  - Line features
- Basins
  - Polygon features that define rainfall catchment area for each outfall

Land Cover Dataset

- Land Cover Dataset includes
  - HLUAs: Homogeneous Land Use Areas
    - Areas of the same land use (Commercial, Actual airport operations, Industrial, Undeveloped, Park / Landscaping Roadway, Parking, Nation Guard)
  - Soils
    - Soil types from National Resource Conversation Service
      - Intended to be used for more advanced permeability modeling of undeveloped/landscaping
  - Surface
      - Pervious / Impervious surfaces

Storm System Topology

Data needed to be "cleaned up"

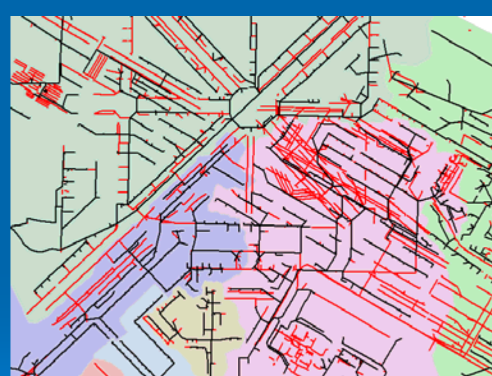
- Abandoned features
- Disconnected, redundant, overlapping features

Assure connectivity

- Create rules
  - Pipe endpoint must be covered by point features
  - Pipe must not have dangles
  - Point features must be covered by pipe

Editing Storm Network

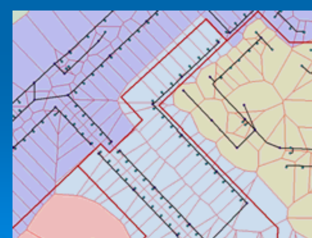
Feature Type	Before Editing	After Editing
Catch Basins	6121	2069
Manholes	2700	1171
Misc. Features	3602	256
Pipes	16876	5426
TOTAL	29299	8922



Editing Basins

Create a more accurate representation of storm basin area based on storm network

- Assume flat surface, water runs to nearest catch basin
- Create Thiessen polygons around catch basins, manholes and misc. features
- Edit basin shapes to match Thiessen polygon boundaries



Editing Land Cover Dataset

- No data in areas of land cover feature classes
- Use aerial photos to interpolate land use and surface

Model - Pollutants

- Total Suspended Solids (TSS)
  - Includes erosion runoff
- Five-day biochemical oxygen demand (BOD_5)
  - How fast organisms use up dissolved oxygen in water
  - Measures amount of organic material in water
- Total Kjeldahl nitrogen (TKN)
  - Sum of organic nitrogen; ammonia, NH3 and ammonium, NH4+
- Nitrate nitrogen (NO_3-N)
  - Runoff from fertilizer
- Total phosphorus (Total P)
  - Organic, Inorganic phosphorus
- Ortho-phosphorus (Ortho P)
  - Only inorganic phosphorus
- Oil and grease
- Copper
- Lead
- Zinc

Model – Event mean concentrations

- Concentrations of pollutants at PDX was modeled with Event Mean Concentrations (EMCs)
- EMCs are a mean value for the previously mentioned pollutants during a precipitation event causing runoff
- The following table was used:

Recommended EMCs (mg/L) for PDX Pollutant Load Model

Land Use	TSS	BOD5	NO3	Total P	Oil & Grease	Cu	Pb
Commercial	69	9.3	0.06	0.2	3.7	0.03	0.1
Industrial	154	68	0.22	0.8	5.3	0.06	0.06
Airport	20	32	0.55	0.05	3.7	0.01	0.01
Roadway	119	20	0.43	0.25	8.9	0.04	0.04
Undeveloped	70	2	0.54	0.12	0.6	0.01	0.03
Parking Lot	27	20	1.9	0.15	8.9	0.05	0.03
Park/Landscaping	37	2	9.1	2.1	0.6	0.09	0.03

- Simple Method of calculating annual pollutant load: $\sum Li = EMCi * Dri$

Model- Best Management Practices

- Best Management practices reduce pollutant loading according to table:

BMP_TYPE	TSS	BOD5	NO3	TOTALP	OIL_GREASE	Cu	Pb	Zn
Detention Pond	0.65	0	0.1	0.19	0.3	0.43	0.58	0.59
Wet Pond	0.91	0.49	0.27	0.43	0.21	0.44	0.6	0.58
Grassy Swale	0.49	-0.07	-0.5	-0.47	0.14	0.47	0.53	0.51
Hydrodynamic Devices	0.44	0.42	0.47	0.45	0.33	0.38	0.43	0.47
Filter Devices	0.86	0	0.4	0.4	0.99	0.82	0.92	0.99
Skimming Booms	0	0	0	0	0.33	0	0	0
Sweep 1X week	0.5	0.28	0.13	0.29	0	0.25	0.38	0.29
Sweep 2X week	0.5	0.39	0.21	0.4	0	0.25	0.56	0.41

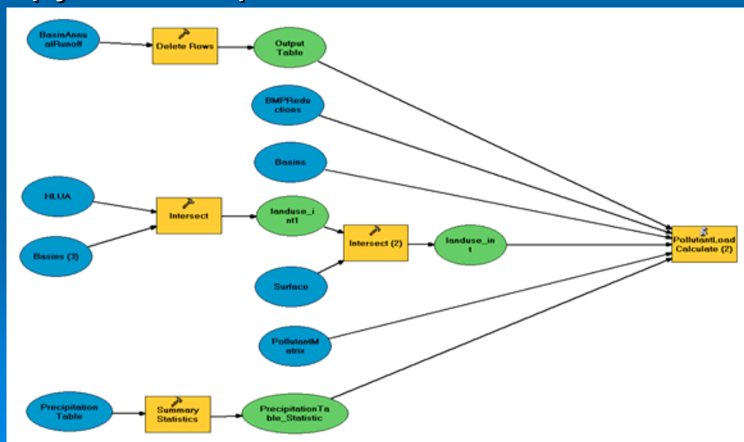
- This gives equation for annual pollutant loading: Annual Pollutant Loading Rate = Annual Runoff Volume x EMC x (1 -BMP Reduction Factor(s))

Model – non spatial tables

- Model utilizes several non-spatial tables:
  - BMP reduction percentages
  - EMC per landuse type
  - Precipitation at PDX over last 70 years (monthly and annually)

Model - Implementation

- Implemented model using Modelbuilder and a python script.



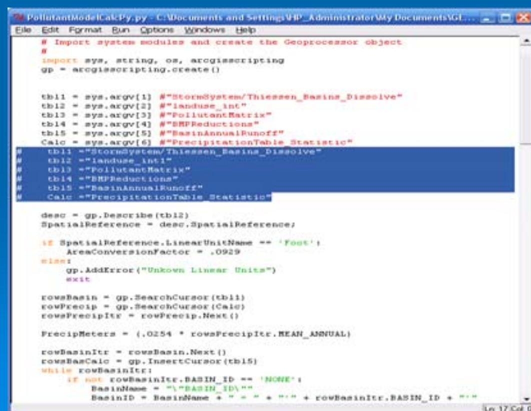
Model – methods

- Perform intersection overlay functions on HLUA, Surface and Catch Basins

- Need this to split HLUA and Surfaces across Catch Basins

Model - Methods

- Calculate average precipitation over 70 year period.
- Python script iterates over all HLUA and Surface types, output is annual pollutant loading in milligrams



Model - Output

- Python script output (mg/year):

Basin	TSS	BOD5	NO3	TOTALP	OIL_GREASE	Cu
1	146545983488	44603473920	5292601856	1252765952	5578414592	73197992
2	9525035008	8317258752	1314503808	274477056	1078167936	14539169
3	2185159680	827466688	28426260	6363547	140673712	993100.5
4	4883998208	3081966848	87382008	14291827	458185376	2392411.75
5	7365101056	1652003072	73812296	21384930	341516992	3187890.25
6	9246468096	13508900864	468799616	56406188	1847369984	7617290.5
7	60377202688	38269071360	1214825856	235129168	5467248128	31871050
8	82700075008	16060965888	938449792	211424816	3643389440	28282778
9	54194249728	9589796864	633025408	137660976	2759839744	23405870
NONE1	4362200576	1926166272	6231714.5	22660782	100585544	1727884.38
NONE2	9337334784	4014496768	14543392	47411220	219550160	3646749.75
NONE3	3023503616	1335053440	4319291	15706513	69717280	1197621.63

Model - Conclusions

- Loading Lbs./Acre

Basin	LbsPerAcreTSS	LbsPerAcreBOD5	LbsPerAcreNO3	LbsPerAcreTOTALP	LbsPerAcreOIL_GREASE	LbsPerAcreCu	LbsPerAcrePb	LbsPerAcreZn
1	224.59	68.36	8.11	1.92	8.55	0.11	0.11	0.74
2	96.05	83.87	13.26	2.77	10.87	0.15	0.06	0.5
3	278.8	105.57	3.63	0.81	17.95	0.13	0.15	0.93
4	206.98	130.61	3.7	0.61	19.42	0.1	0.11	0.7
5	366.35	82.17	3.67	1.06	16.99	0.16	0.2	1.21
6	89.8	131.2	4.55	0.55	17.94	0.07	0.05	0.32
7	194.2	123.09	3.91	0.76	17.59	0.1	0.09	0.54
8	360.92	70.09	4.1	0.92	15.9	0.12	0.16	0.77
9	436.47	77.23	5.1	1.11	22.23	0.19	0.21	0.92
NONE1	1163.47	513.74	1.66	6.04	26.83	0.46	0.45	3.4
NONE2	1097.26	471.75	1.71	5.57	25.8	0.43	0.42	3.13

- "Typical Loading Rates"

Land Use	TSS	BOD5	NO3	TOTALP	Cu	Pb	Zn
Commercial	1000	62	6.7	1.5	0.4	2.7	2.1
Parking	400	47	5.1	0.7	0.04	0.8	0.8
Freeway	880	-	7.9	0.9	0.37	4.5	2.1
Industrial	860	-	3.8	1.3	0.5	2.4	7.3
Park	3	-	1.5	0.03	-	0	-

Model – HLUA distribution by basin

- HLUA Percentage of each basin

Basin	Park	Undeveloped	Airport	Commercial	Industrial	Roadway	Parking	Oregon Air Guard.
1	4.13	11	75.86	3.44	3.44	2.07	0	0
2	1.49	1.49	91	5.97	0	0	0	0
3	0	0	20.45	79.54	0	0	0	0
4	0	0	13.95	86	0	0	0	0
5	0	0	16.13	81.72	0	0	0	0
6	0	0	16.45	0	0	1.54	1.8	79.18
7	1.55	3.3	39	18.18	8.2	10.2	17.52	2.66
8	1.39	6.94	7.34	18.45	5.75	31.94	28.17	0
9	0	4.06	0	1.56	0	14.06	80.31	0
NONE1	0	100	0	0	0	0	0	0
NONE2	0	12	0	0	72	16	0	0
NONE3	0	0	0	0	100	0	0	0

Results

- Predicted and measured pollutant concentrations
  - Modelled results similar to Kennedy/Jenks results
    - Probably more spatially accurate

	TSS	BOD5	NO3	TOTAL P	OIL GREASE	Cu	Pb	Zn
Kennedy/Jenks Model Output	25	28	.57	.09	2.66	.01	.013	.07
Model Mean	28.86	10.40	0.77	0.17	1.63	0.014	0.014	0.082
Measured Mean	11	4.3	NM	0.14	8.1	0.01	0.0027	0.05
Measured Max	23	9	NM	0.25	100	0.01	0.0088	0.24
1200-COLS Benchmark	50	33	No Value	0.16	10	0.036	0.006	0.24

References

Final Strategic Environmental Evaluation Stormwater Pollutant Load Model Report – Portland International Airport, Kennedy/Jenks Consultants, 2005.

Portland International Airport Master Plan

General Information on Phosphorus:

http://bcn.boulder.co.us/basin/data/FECAL/info/TP.html