Ohio Public Water Systems and Phosphate Use … revisited

Lake Erie Phosphorus Task Force Meeting

June 25, 2008

OhioEPA

Outline

- "Cliff Notes" review of 2007 presentation
- PWS options for corrosion control – and what they typically select in Ohio
- Statistics on PWS phosphate use
- WWTP effluent vs. PWS phosphate levels

2007 “Cliff Notes”

- Phosphates added for corrosion control, Fe/Mn sequestration, filter aid, scale inhibition and chlorine stabilization
- Forms used in Ohio are phosphate, orthophosphate, polyphosphates, Zinc orthophosphate
- Lead and Copper Rule Timeframe:
  - **1991** USEPA Lead and Copper Rule
  - **1993** Ohio EPA adopted lead and copper rules
  - **Mid-90s to current** PWS compliance with rule phased in, systems adding Corrosion Control or alternative

Corrections – Examples of PWSs using PO4

Our central database contained a number of incorrect dates (data migration issues)… highlighting the difficulties of compiling an accurate basin-wide assessment of who adds phosphate and when.

Bucyrus (prior to 1979), Upper Sandusky (Prior to 1982)

- ~~2001 PO4 addition~~

Fremont (prior to 1978)

- ~~2000 PO4 addition~~

Toledo (1997), Cleveland (1996)

Akron – prior to 1992 PO4 addition

- 1998 OEPA letter requiring 0.6 mg/L minimum

Corrosion Control – Options

If high lead and copper results trigger CC treatment, then systems chose one of the following:

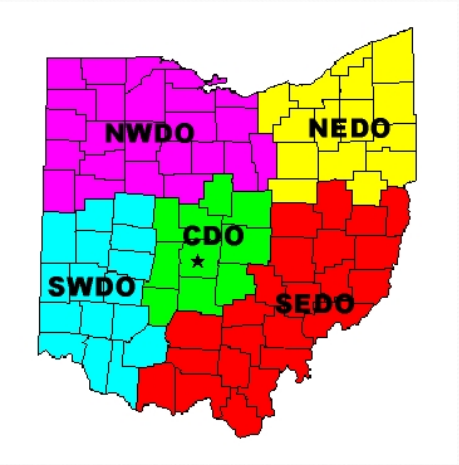
- pH and CaCO3 Control (used often in Ohio)
- Lead line replacement (costly and not widely done)
- Addition of corrosion inhibitor
  - Phosphate-based: zinc orthophosphate, orthophosphate, PO4, or polyphosphate, blend of Ortho-P and PO4
  - Silica-based : listed in rule but little or no current application in OH

Some PWS are changing the form of inhibitor in response to Pb/Cu Rule

Typical Dosing Levels

- Initial build-up period (target 1.0-3.0 mg/L - total PO4)
- Maintenance Levels
  - Target 0.5-1.0 mg/L
  - Actual Phosphate Levels in Finished Water NW/NE Districts is 0.59 mg/L (mostly within 0.05-1.2 mg/L)
- Data reviewed from PWS MORs submitted electronically. All other MORs stored in OEPA district files

Ohio EPA Districts



This study focused on the NW and NE districts

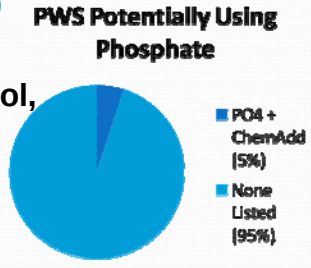
How many PWS Add Phosphate in our Northern districts?

NWDO and NEDO Summary

(3267 total SW, GW, **PSW, PGW**)

Treatment Objective = Corrosion Control, FeMn Removal, Filter Aid, Other

- "Phosphate Added" 106/3267 (3.2%)
- "Chemical Addition" 59/3267 (1.8%)



Assumed all "chemical addition" was phosphate – possibly an overestimate

Minnesota Phosphorus Study

- 2003 Public concern over eutrophication…pressure to ban P in automatic dishwasher detergents
- 2004 Comprehensive Report included analysis of Point and Non Point Sources with estimated Total P and Bioavailable P for each source.
- **Estimated Contribution to POTWs from Water Treatment Chemicals ranges from 1.7% to 5.7% in each of the basins and was 3.1% statewide of the total POTW influent phosphorus.**
- For comparison purposes: approximately 40% of Minnesota PWS use some form of phosphate (~5% of Ohio LE basin PWS use PO4 but ~ 50% of the population on public water)

What did we look at?

Requested to review our PWS phosphate data in greater detail and compare with WWTP effluent (total P)

Key Question…

Is there a correlation between PWS initiation of Phosphate treatment and increased Total P levels in the WWTP effluent?

WWTP Discharge Data

- 1990-2006 Ohio EPA SWIMS database
- WWTP – Total P and Flow from major and minor NPDES permitted dischargers in the LE B
- Basin-wide trends
- WWTP and local PWS comparison

Basin-wide Trends

- Majors: Total P limit = 1.0 mg/L in Lake Erie Basin
  - Discharge >1 MGD
  - Most have very consistent Total P levels in their effluent and trends in discharge not evident (no surprise here)
- Minors: No basin-wide P limit in Lake Erie Basin
  - Wide variation in Total P concentration from facility to facility and at the same station
  - Overall trend (AJ CHECK) slight decrease in Total P levels in last few years (probably related to taking care of "bad actors")

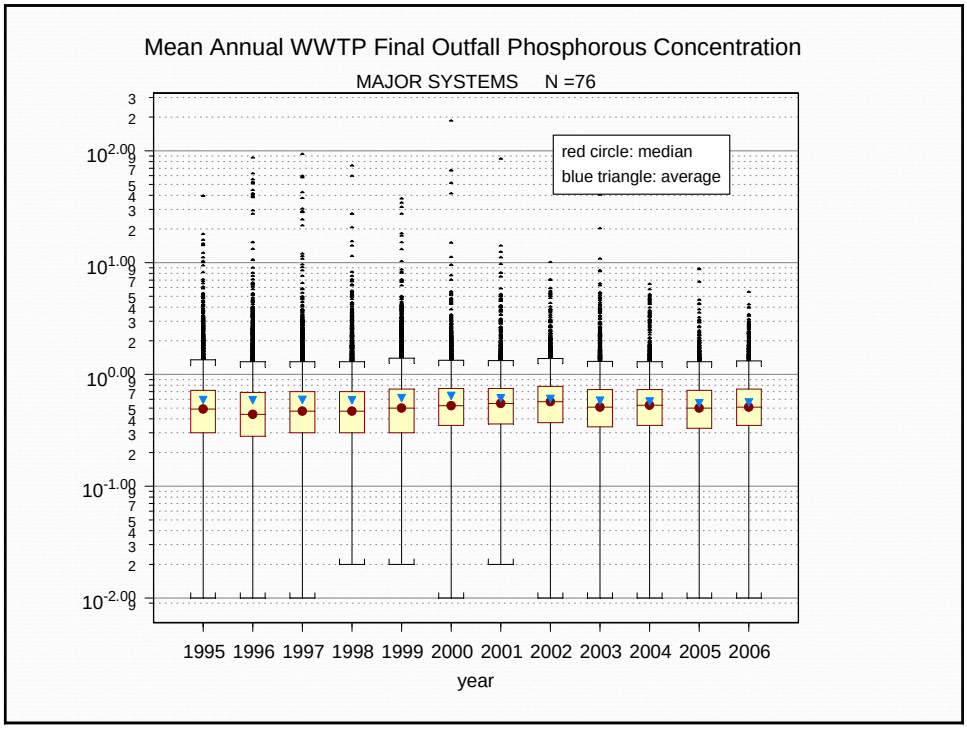
WWTP-PWS Comparison

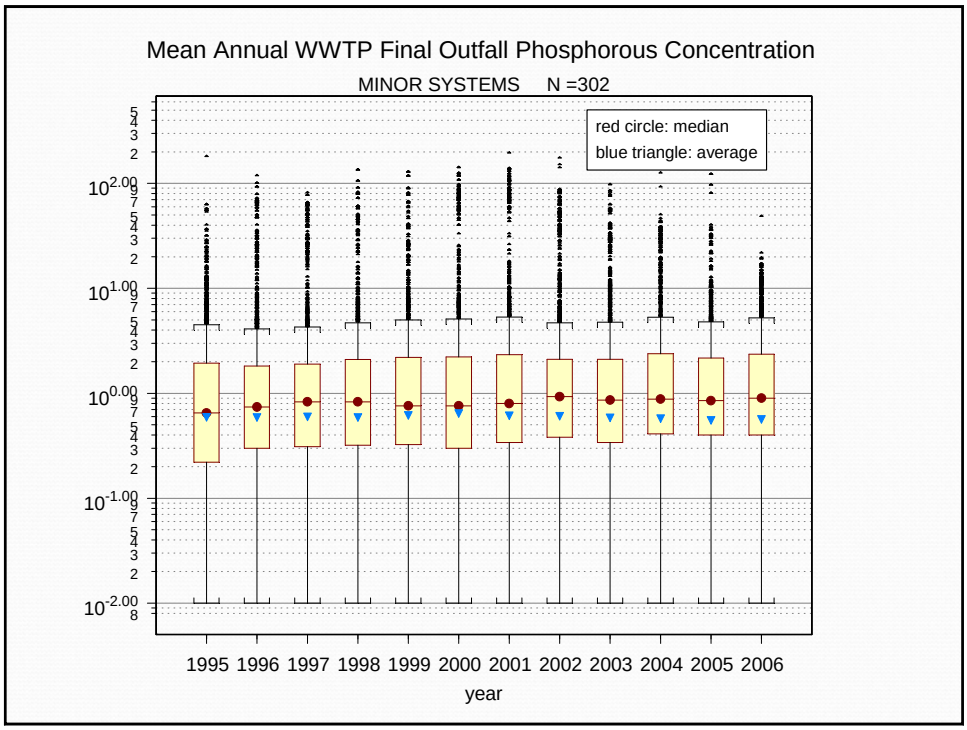
Selection criteria

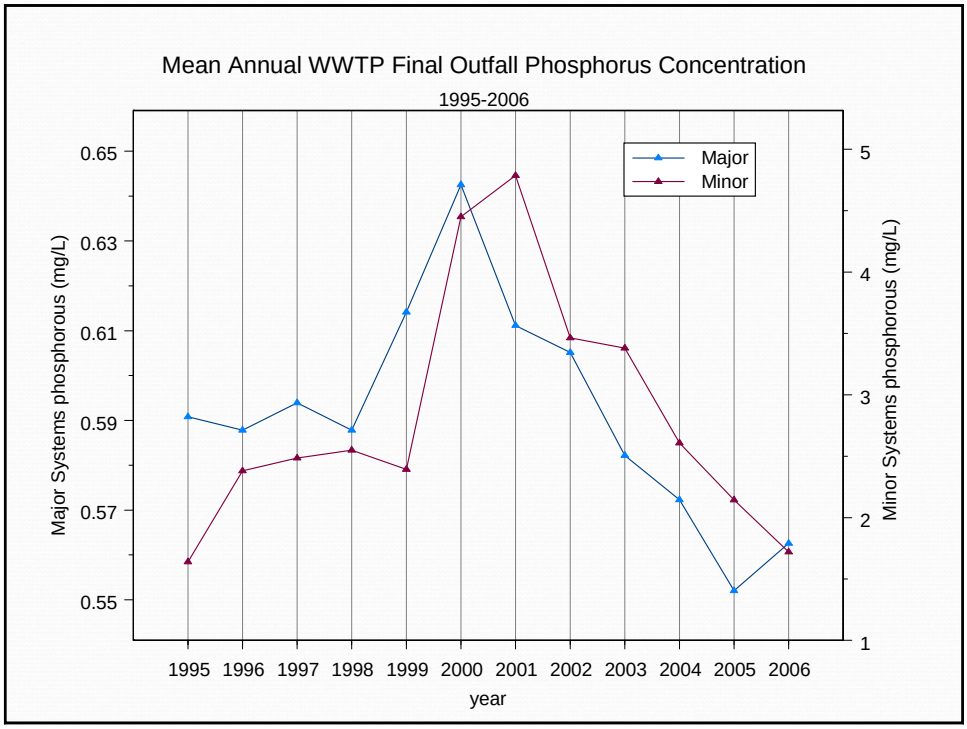
- PWS data available
- PWS added PO4 to process during 1996-2
  - Date of change and dosing levels known
- WWTP and PWS serve same area and assume that the PWS is primary source to the WWTP
- Attempted to identify both Major and Minor WWTPs and in multiple watersheds

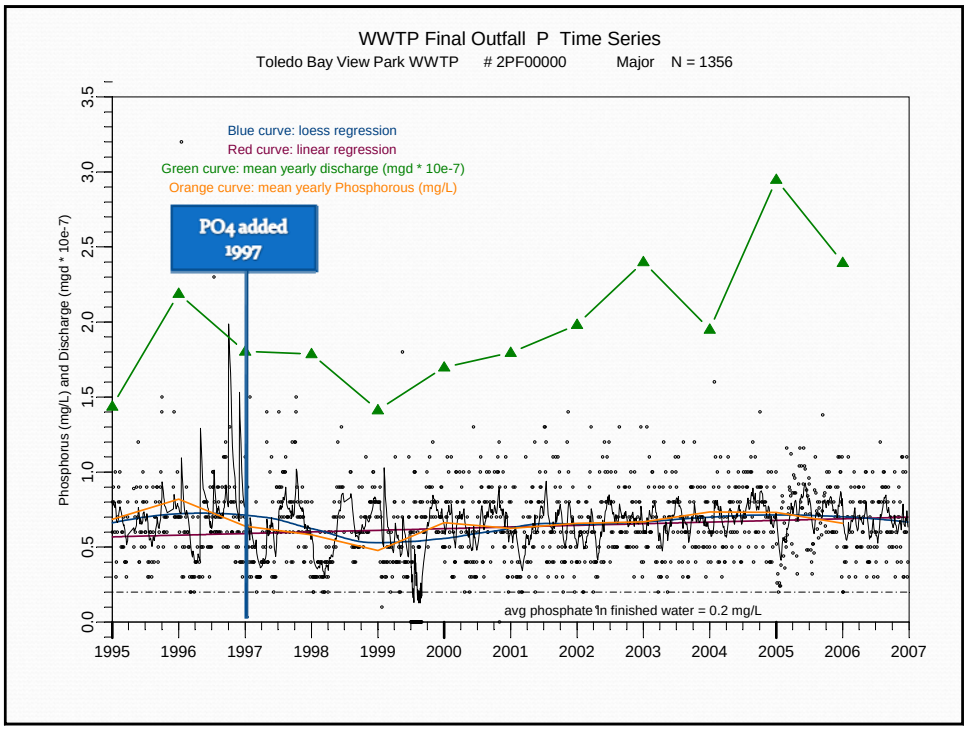
PWS-WWTP Comparisons

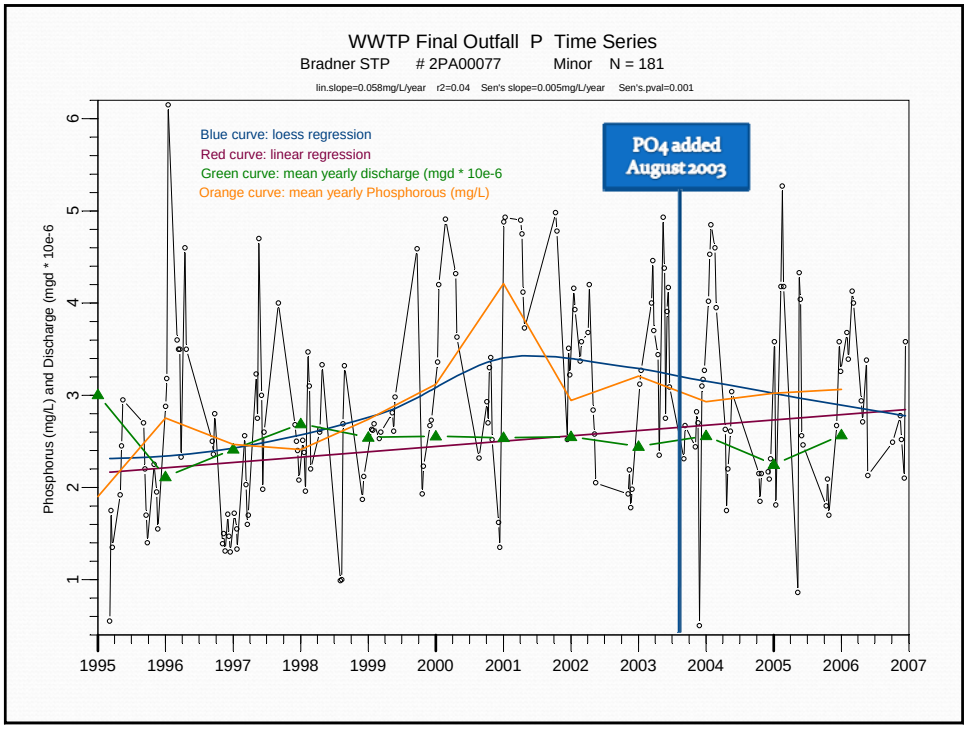
- Toledo PWS: Added PO4 in 1997 (avg=0.3mg/L), Major WWTP
- Swanton PWS: Added PO4 in 2001 (avg=0.8 mg/L), Major WWTP
- Farmland Foods: Added PO4 mid-2006 (avg=?), Minor WWTP
- Bradner PWS: Added PO4 in August 2003 (avg=0.3-1.2), Minor WWTP
- Ottawa County Regional PWS: Added PO4 in Oct 2004 (avg=0.3-0.6)
  - Portage Cataba Island WWTP, Minor
  - Danbury Twp WWTP, Major
  - Oak Harbor WWTP, Minor
  - Port Clinton WWTP, Major

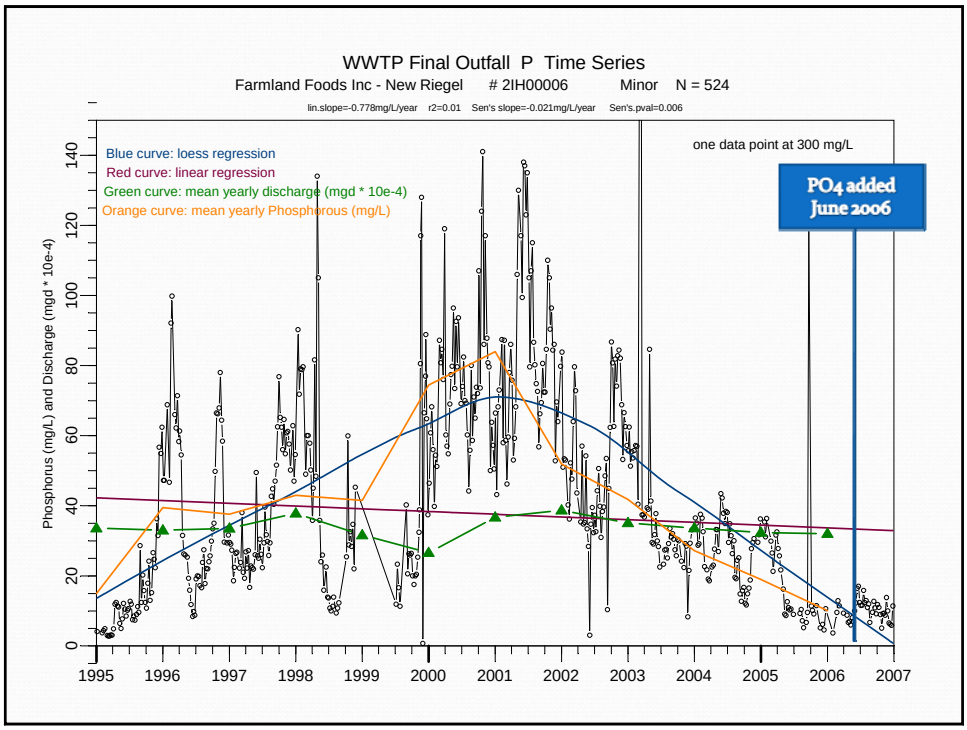

Mean Annual WWTP Final Outfall Phosphorous Concentration
MAJOR SYSTEMS N =76
red circle: median
blue triangle: average
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
year

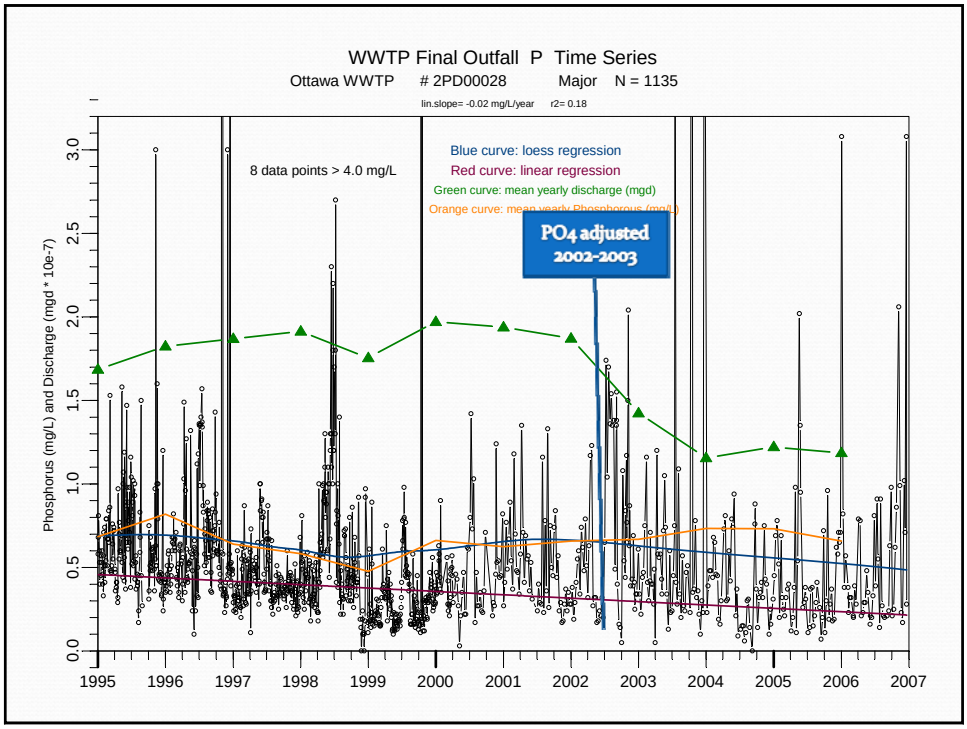

Mean Annual WWTP Final Outfall Phosphorous Concentration
MINOR SYSTEMS N =302
red circle: median
blue triangle: average
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
year

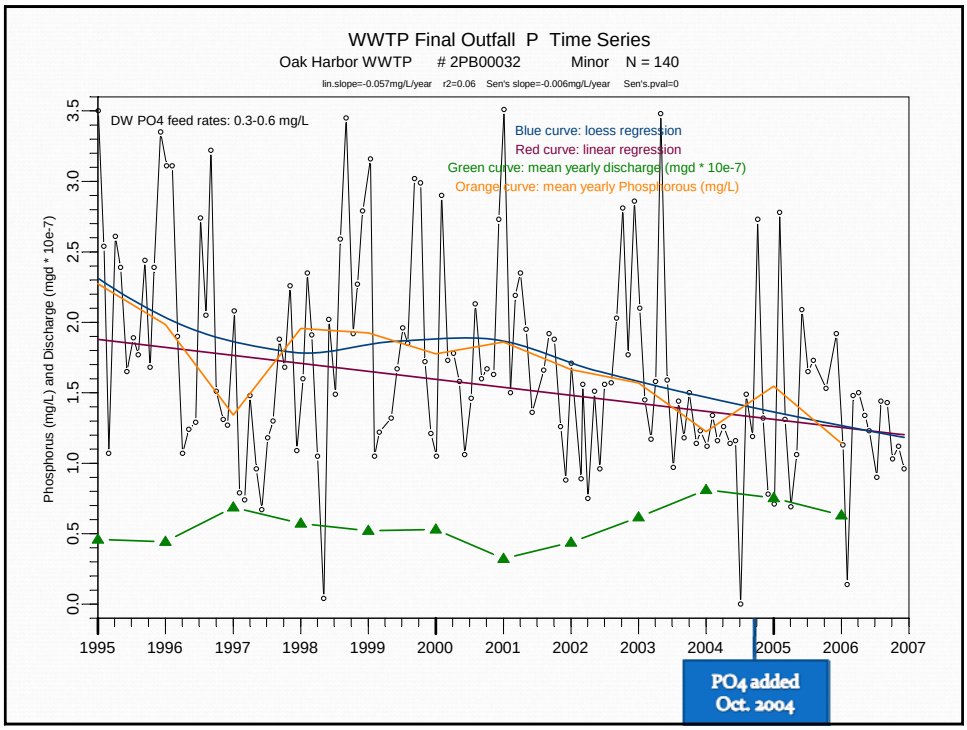

Mean Annual WWTP Final Outfall Phosphorus Concentration
1995-2006
Major
Minor
Major Systems phosphorous (mg/L)
Minor Systems phosphorous (mg/L)
0.65
0.63
0.61
0.59
0.57
0.55
5
4
3
2
1
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
year

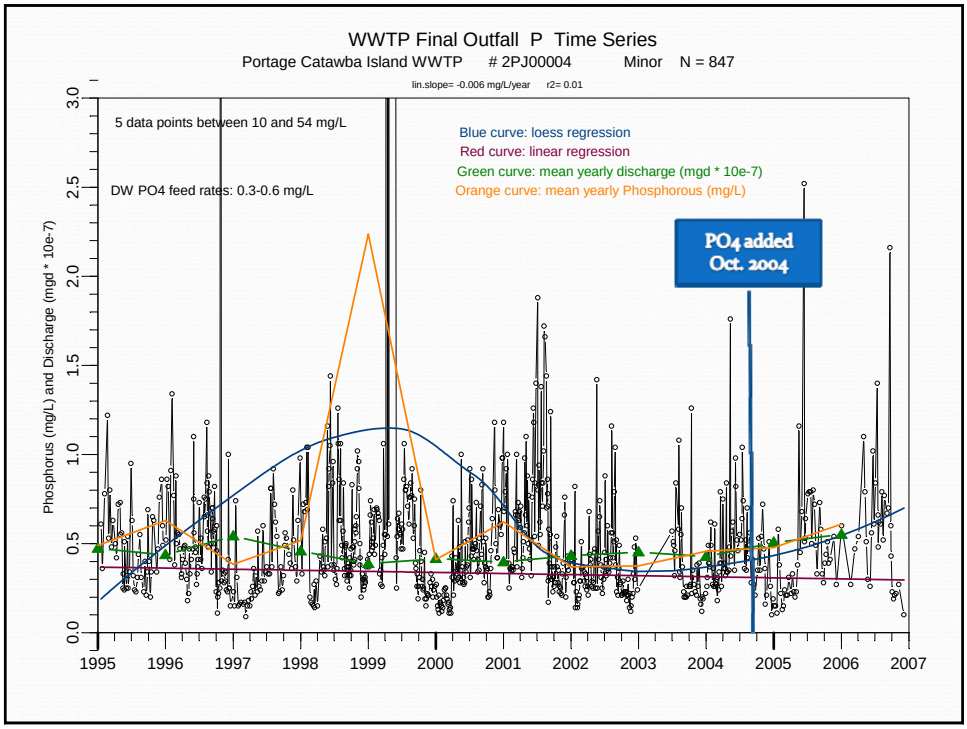

WWTP Final Outfall P Time Series
Toledo Bay View Park WWTP # 2PF00000 Major N = 1356
Blue curve: loess regression
Red curve: linear regression
Green curve: mean yearly discharge (mgd * 10e-7)
Orange curve: mean yearly Phosphorous (mg/L)
PO4 added 1997
Phosphorus (mg/L) and Discharge (mgd * 10e-7)
avg phosphate in finished water = 0.2 mg/L
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

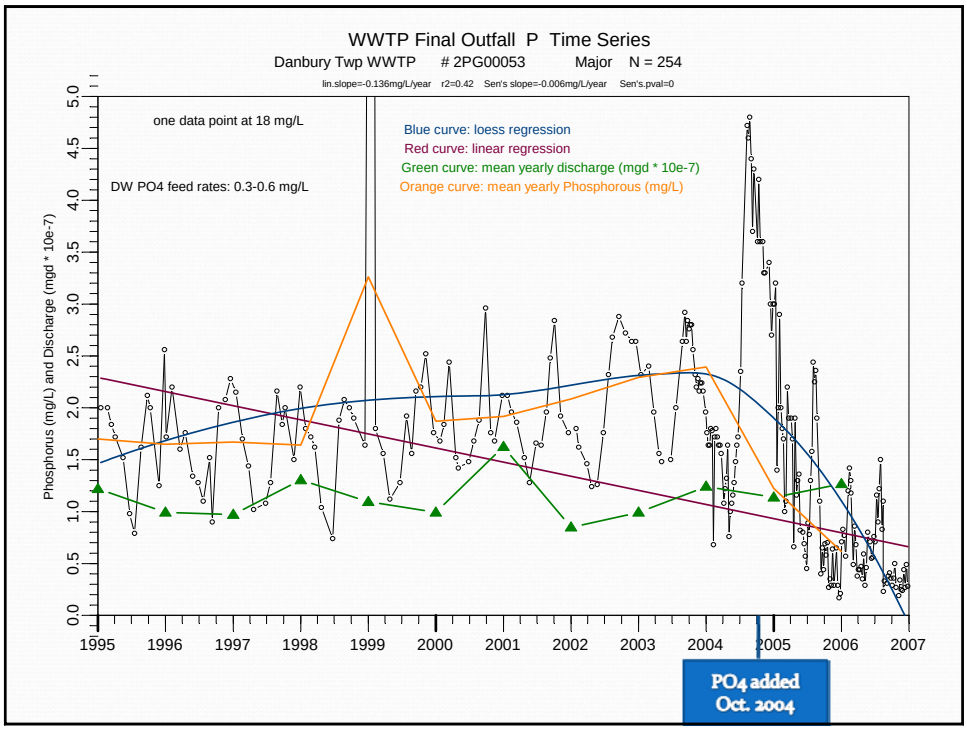

WWTP Final Outfall P Time Series
Bradner STP # 2PA00077 Minor N = 181
lin.slope=0.058mg/L/year r2=0.04 Sen's slope=0.005mg/L/year Sen's.pval=0.001
Blue curve: loess regression
Red curve: linear regression
Green curve: mean yearly discharge (mgd * 10e-6
Orange curve: mean yearly Phosphorous (mg/L)
PO4 added August 2003
Phosphorus (mg/L) and Discharge (mgd * 10e-6
1 2 3 4 5 6
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

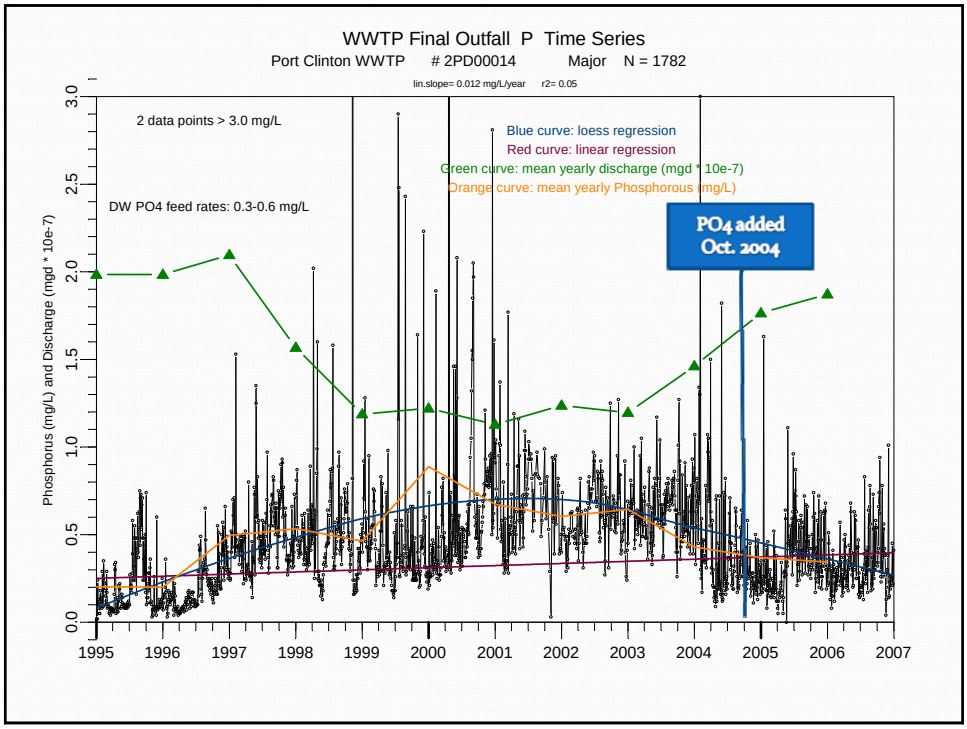

WWTP Final Outfall P Time Series
Farmland Foods Inc - New Riegel # 2IH00006 Minor N = 524
lin.slope=-0.778mg/L/year r2=0.01 Sen's slope=-0.021mg/L/year Sen's.pval=0.006
one data point at 300 mg/L
Blue curve: loess regression
Red curve: linear regression
Green curve: mean yearly discharge (mgd * 10e-4)
Orange curve: mean yearly Phosphorous (mg/L)
PO4 added June 2006
Phosphorus (mg/L) and Discharge (mgd * 10e-4)
0 20 40 60 80 100 120 140
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007


WWTP Final Outfall P Time Series
Ottawa WWTP # 2PD00028 Major N = 1135
lin.slope= -0.02 mg/L/year r2= 0.18
8 data points > 4.0 mg/L
Blue curve: loess regression
Red curve: linear regression
Green curve: mean yearly discharge (mgd)
Orange curve: mean yearly Phosphorous (mg/L)
PO4 adjusted 2002-2003
Phosphorus (mg/L) and Discharge (mgd * 10e-7)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007


WWTP Final Outfall P Time Series
Oak Harbor WWTP # 2PB00032 Minor N = 140
lin.slope=-0.057mg/L/year r2=0.06 Sen's slope=-0.006mg/L/year Sen's.pval=0
DW PO4 feed rates: 0.3-0.6 mg/L
Blue curve: loess regression
Red curve: linear regression
Green curve: mean yearly discharge (mgd * 10e-7)
Orange curve: mean yearly Phosphorous (mg/L)
Phosphorus (mg/L) and Discharge (mgd * 10e-7)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
PO4 added Oct. 2004


WWTP Final Outfall P Time Series
Portage Catawba Island WWTP # 2PJ00004 Minor N = 847
lin.slope= -0.006 mg/L/year r2= 0.01
5 data points between 10 and 54 mg/L
DW PO4 feed rates: 0.3-0.6 mg/L
Blue curve: loess regression
Red curve: linear regression
Green curve: mean yearly discharge (mgd * 10e-7)
Orange curve: mean yearly Phosphorous (mg/L)
PO4 added Oct. 2004
Phosphorus (mg/L) and Discharge (mgd * 10e-7)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007


WWTP Final Outfall P Time Series
Danbury Twp WWTP # 2PG00053 Major N = 254
lin.slope=-0.136mg/L/year r2=0.42 Sen's slope=-0.006mg/L/year Sen's.pval=0
one data point at 18 mg/L
DW PO4 feed rates: 0.3-0.6 mg/L
Blue curve: loess regression
Red curve: linear regression
Green curve: mean yearly discharge (mgd * 10e-7)
Orange curve: mean yearly Phosphorous (mg/L)
PO4 added Oct. 2004
Phosphorus (mg/L) and Discharge (mgd * 10e-7)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007



Thank you !!

- Michael Slattery - conducted statistical analysis and graphical presentations (S-Plus)
- DSW – for providing the SWIMS – NPDES data

Questions??

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