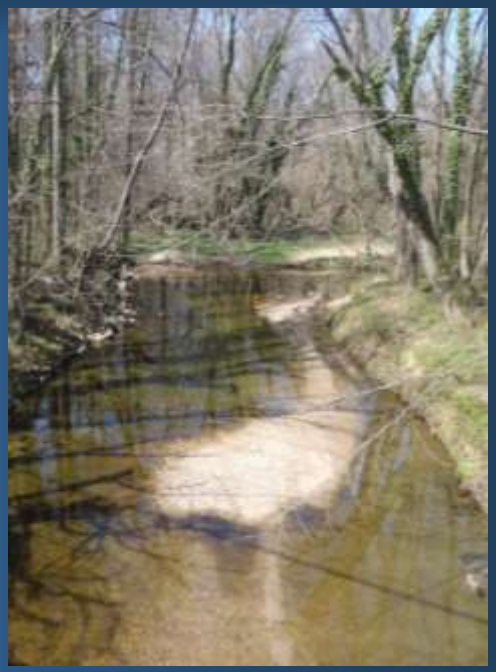
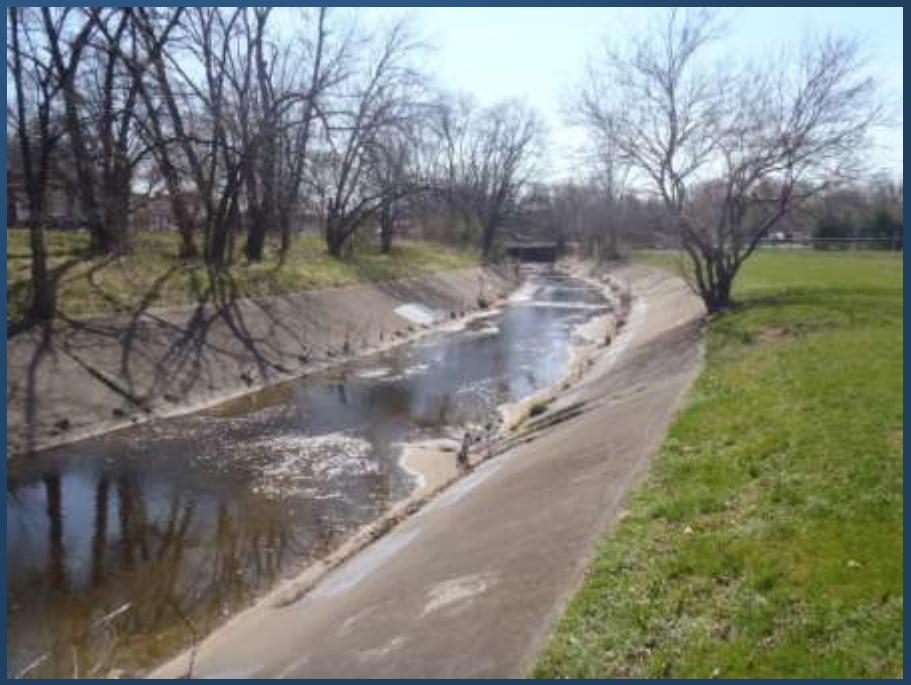
Benthic Total Maximum Daily Load Studies for Holmes Run and Tripps Run



Technical Advisory Committee Meeting

May 24, 2012



Meeting Agenda

- **Water Quality Assessments and TMDL Process**

  Jennifer Carlson

  VA Department of Environmental Quality (DEQ)

- **Preliminary Stressor Analysis**

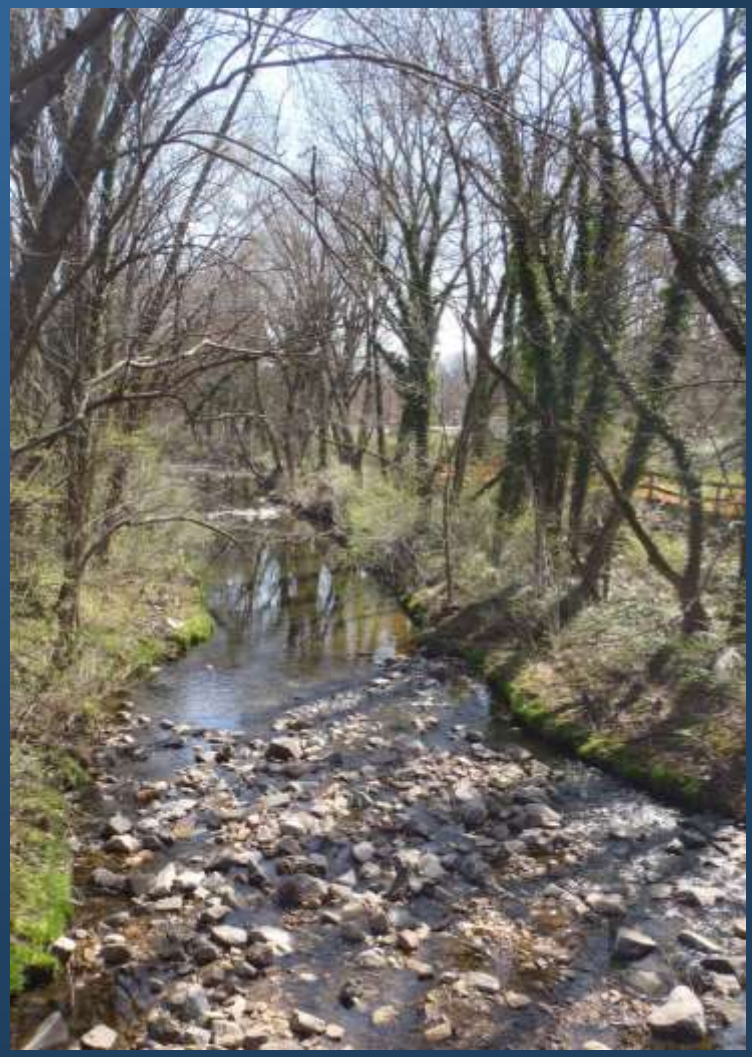
  Ross Mandel

  Interstate Commission on the Potomac River Basin (ICPRB)

- **Questions and Discussion**

Why are we here?

- To learn about water quality in portions of Holmes Run and Tripps Run.
- To explain efforts that Virginia is undertaking to improve and protect water quality.
- To solicit feedback on the direction of this project – several potential stressors in these streams.

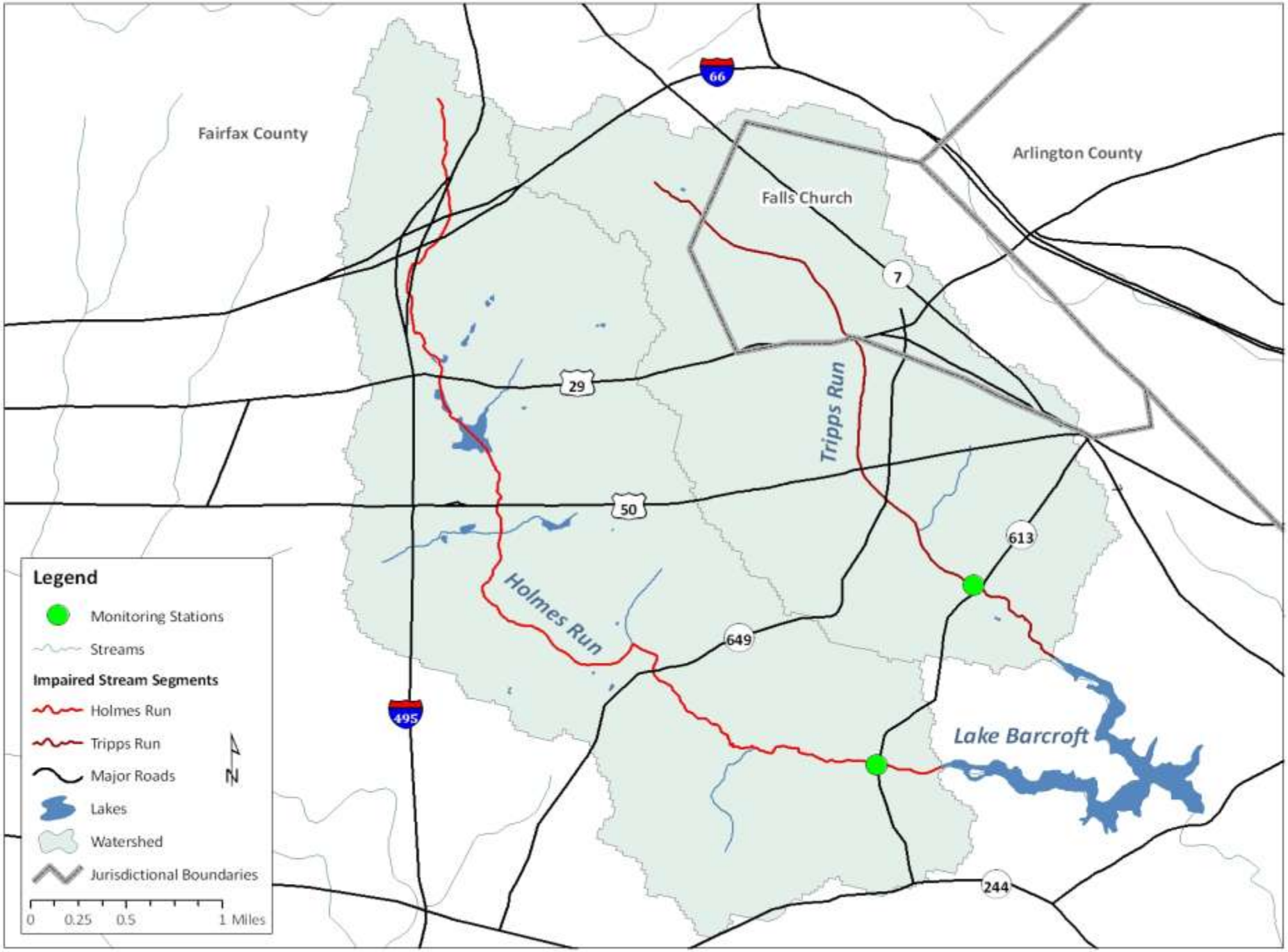


Who is involved in this process?

DEQ :	**Lead Agency for TMDL Development**
DCR :	**Partners with DEQ in TMDL Development, Lead Agency for TMDL IP Development**
Contractor:	**Performs Modeling for TMDL Development (for this project, contractor is the Interstate Commission on the Potomac River Basin).**
TAC:	**Representatives from state and local governments, watershed groups, planning district commission, soil and water conservation districts, etc. Provides technical input and information for TMDL development.**
Citizens:	**Any citizen who wishes to participate in the project; provide local knowledge and information.**

Impairment Descriptions

Stream Name	Location	Impairment	Area (miles)	Upstream Limit	Downstream Limit
Holmes Run	Fairfax County	Aquatic Life Use Benthic Macroinvertebrates	5.78	Headwaters of Holmes Run	Start of Lake Barcroft
Tripps Run	Falls Church Fairfax County	Aquatic Life Use Benthic Macroinvertebrates	2.24	Headwaters of Tripps Run	Start of Lake Barcroft


Fairfax County
Arlington County
Falls Church
66
7
29
50
613
649
495
244
Tripps Run
Holmes Run
Lake Barcroft
Legend
Monitoring Stations
Streams
Impaired Stream Segments
Holmes Run
Tripps Run
Major Roads
Lakes
Watershed
Jurisdictional Boundaries
N
0 0.25 0.5 1 Miles

How do we know if water bodies in Virginia are healthy?

- Perform physical and chemical monitoring on water bodies throughout the state
- Monitor parameters such as:
  - pH
  - Temperature
  - Dissolved Oxygen
  - Biological Community
  - Bacteria
  - Nutrients
  - Fish Tissues
  - Metals/Toxic Pollutants

What do we do with the monitoring data that is collected?

Compare the data collected to the water quality standards

Water Quality Standards:

- Regulations based on federal and state law
- Set numeric and narrative limits on pollutants
- Consist of designated use(s) and water quality criteria to protect the designated uses

Designated Uses

- Recreational
- Public Water Supply
- Wildlife
- Fish Consumption
- Shellfish
- Aquatic Life

From the Virginia Water Quality Standards:
9VAC25-260-10. Designation of uses.
A. All state waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of ***aquatic life****, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish.*

Aquatic Life Use

- **From the Virginia Water Quality Standards:**

  9VAC25-260-20. General criteria.
  A. State waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life.

- **The attainment of the aquatic life use is evaluated by testing for the health of the benthic macroinvertebrate community, as well as for parameters such as DO and pH. The aquatic life use impairments on Holmes Run and Tripps Run were listed because of poor health in the benthic macroinvertebrate community.**

Aquatic Life Use: What are benthic macroinvertebrates?

Aquatic invertebrates that live on the bottom of streams, rivers, and other bodies of water.

Why use benthic macroinvertebrates as an indicator of stream health?

- Often live > one year – thus, they can show the effects of pollutants over a period of time, rather than just at one single moment.
- Sedentary in nature – good indicators of localized conditions.
- Live in the water for most, or all, of their life.
- Are easy to collect and identify.
- Differ in their tolerance to amount and type of pollution.
- Show integrated effects of environmental conditions .

Aquatic Life Use Impairment: Benthic Macroinvertebrates

Pollution Intolerant Invertebrates

Mayfly

Stonefly

Caddisfly

Moderately Pollution Tolerant Invertebrates

Crayfish

Water Penny

Net spinning Caddisfly

Highly Pollution Tolerant Invertebrates

Midge Larvae

Segmented Worm

Leech

Holmes Run and Tripps Run Benthic Impairment Information

Sample Date	SCI* Scores by Station	
	Holmes Run 1AHOR005.48 Sleepy Hollow Road	Tripps Run 1ATRI001.50 Sleepy Hollow Road
6/9/2004	30.7	34.8
11/29/2004	35.5	35.6
9/25/2007	N/A	23.7
11/8/2007	39.7	N/A
4/7/2008	18.7	24.9
10/1/2008	40.2	44.7
4/15/2010	32.9	26.2
11/9/2010	37.1	21.6

**Target Virginia Stream Condition Index Score (SCI Score) is 60 or above.*

What happens when a water body doesn't meet water quality standards?

- Waterbody is listed as "impaired" and placed on the 303(d) list
- Once a water body is listed as impaired, a Total Maximum Daily Load value must be developed for that impaired stream segment to address the designated use impairment
- TMDL Studies are required by law:
  - 1972 Clean Water Act (CWA)
  - 1997 Water Quality Monitoring Information and Restoration Act (WQMIRA)

What is a TMDL ?

Total Maximum Daily Load

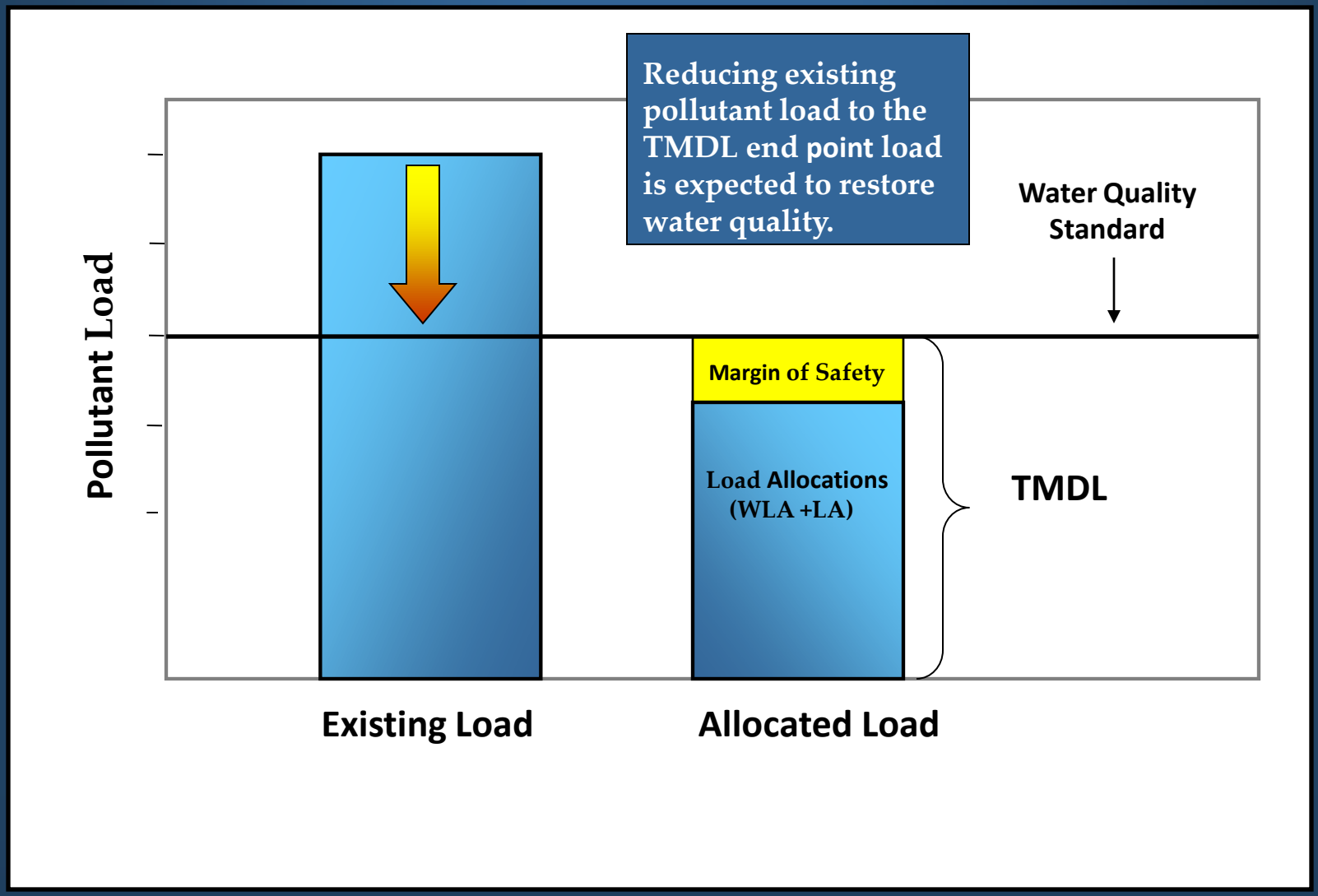
TMDL = Sum of WLA + Sum of LA + MOS

Where:

TMDL = Total Maximum Daily Load
WLA = Waste Load Allocation (Point Sources)
LA = Load Allocation (Non-point Sources)
MOS = Margin of Safety (Implicit or Explicit)

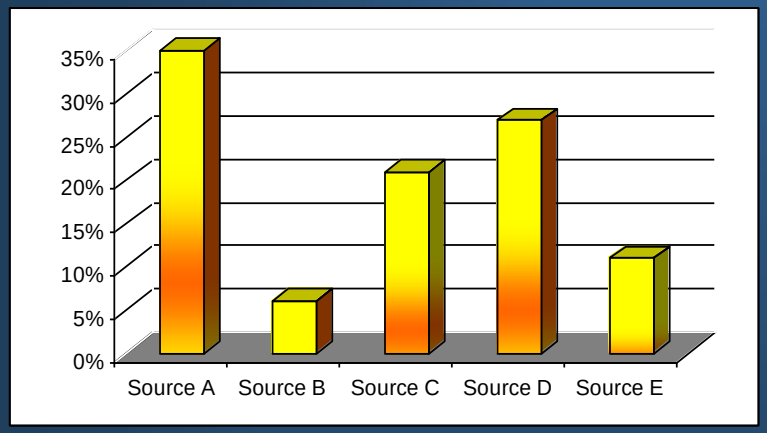
A TMDL is the total amount of a certain pollutant that a water body can receive and still not exceed water quality standards.

An Example TMDL



TMDL Development Methodology

1. Analyze data for the watershed to determine what is causing the benthic macroinvertebrate impairment (Stressor Analysis).

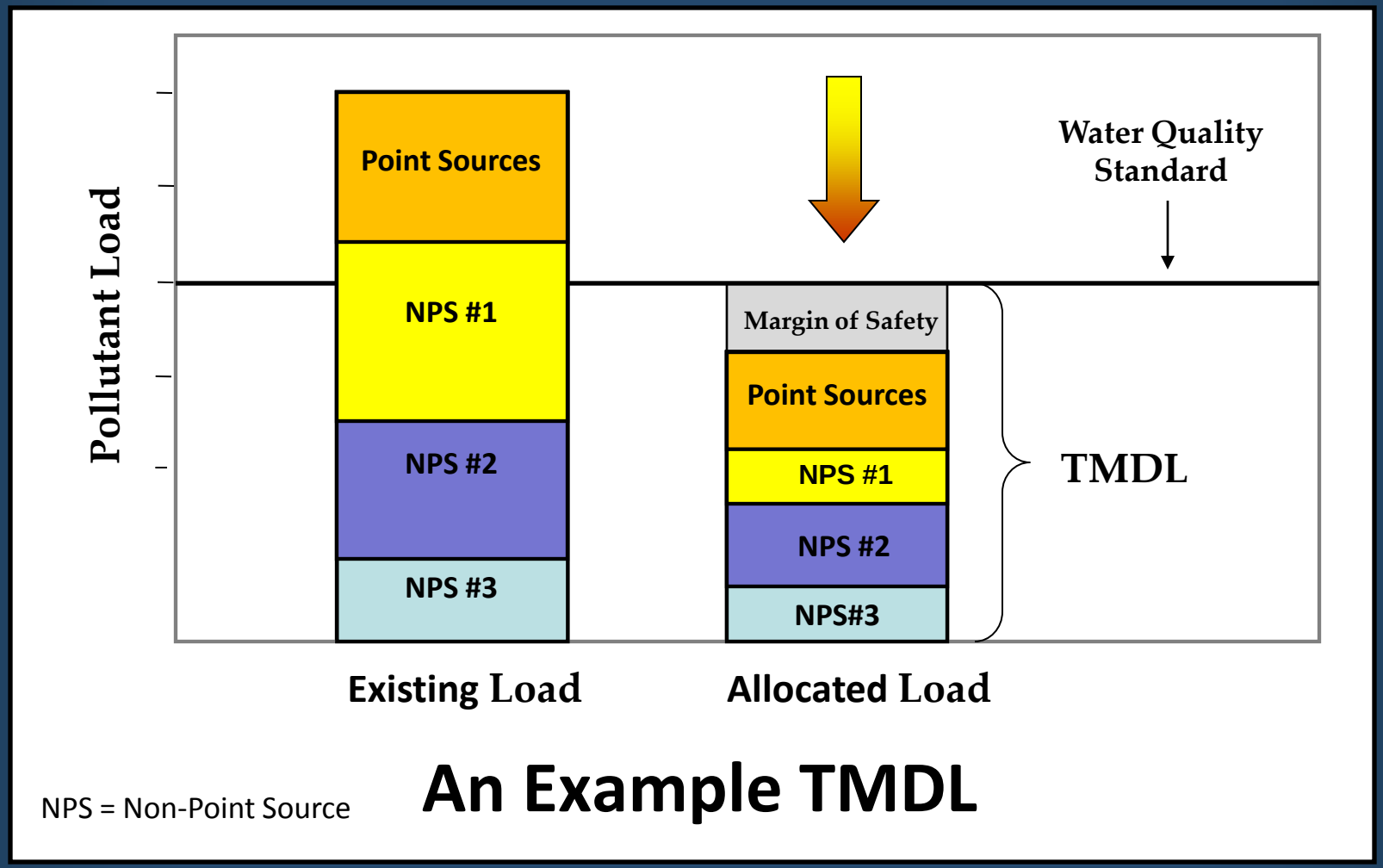


2. Calculate the amount of pollutant entering the stream from each source type.
3. Enter available data into a computer model. Model simulates pollutant loadings into the watershed.
4. Use the model to calculate the pollutant reductions needed, by source, to attain Water Quality Standards.

5. Allocate the allowable loading to each source and include a margin of safety.

TMDL Development Methodology

Use the model to calculate the pollutant reductions needed, by source, to attain Water Quality Standards. Allocate the allowable loading to each source and include a margin of safety.



NPS = Non-Point Source

An Example TMDL

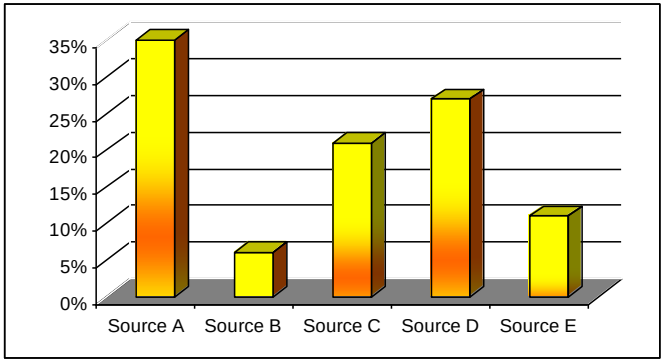
Required Elements of a TMDL

A TMDL must:

- Be developed to meet Water Quality Standards
- Be developed for critical stream conditions
- Consider seasonal variations
- Consider impacts of background contributions
- Include wasteload and load allocations (WLA, LA)
- Include a margin of safety (MOS)
- Be subject to public participation
- Provide reasonable assurance of implementation

We are here

TMDL Study

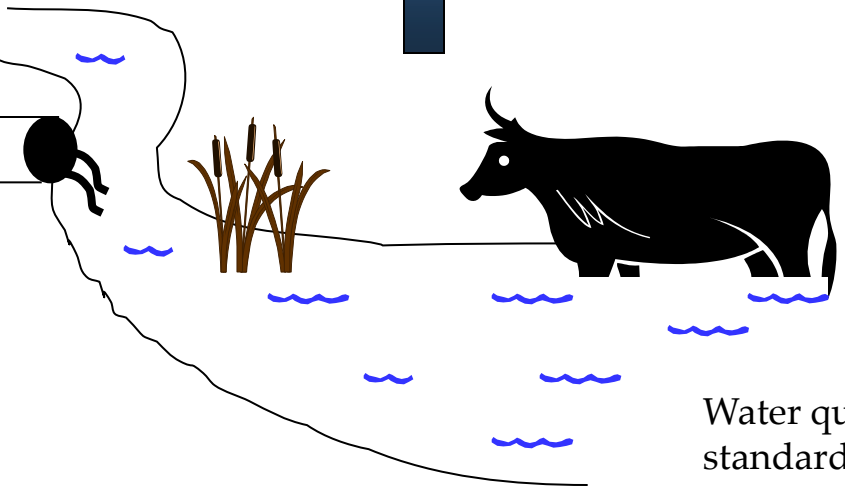


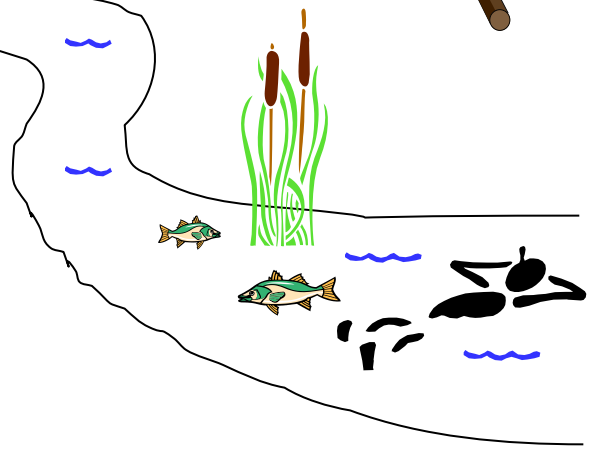
Implementation Plan

DCR

Implementation

Monitoring





Water quality standards not met

Stressor Analysis for Holmes Run and Tripps Run

What is a Stressor Analysis?

Answers the question: ***What pollutant is causing the aquatic life impairment?***

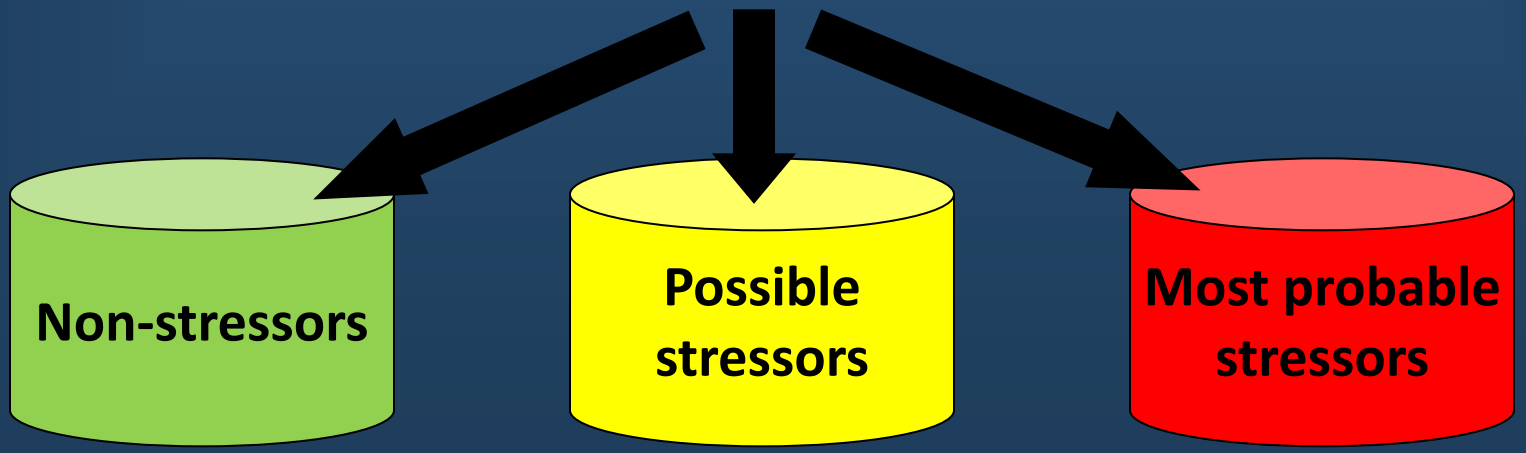
1. List all potential causes, for example:

   DO, nutrients, pH, sediment, temperature, toxics, etc.

2. Analyze the evidence for and against each pollutant:

   Biological, habitat, water quality, historic data, etc.

3. Categorize each of the causes as being one of the following:



Potential Stressors

- Temperature
- pH
- DO
- Total Dissolved Solids
- Chlorides
- Conductivity
- Nutrients
- Metals
- Toxics
- Sediment
- Hydro-modification

VA Water Quality Standards

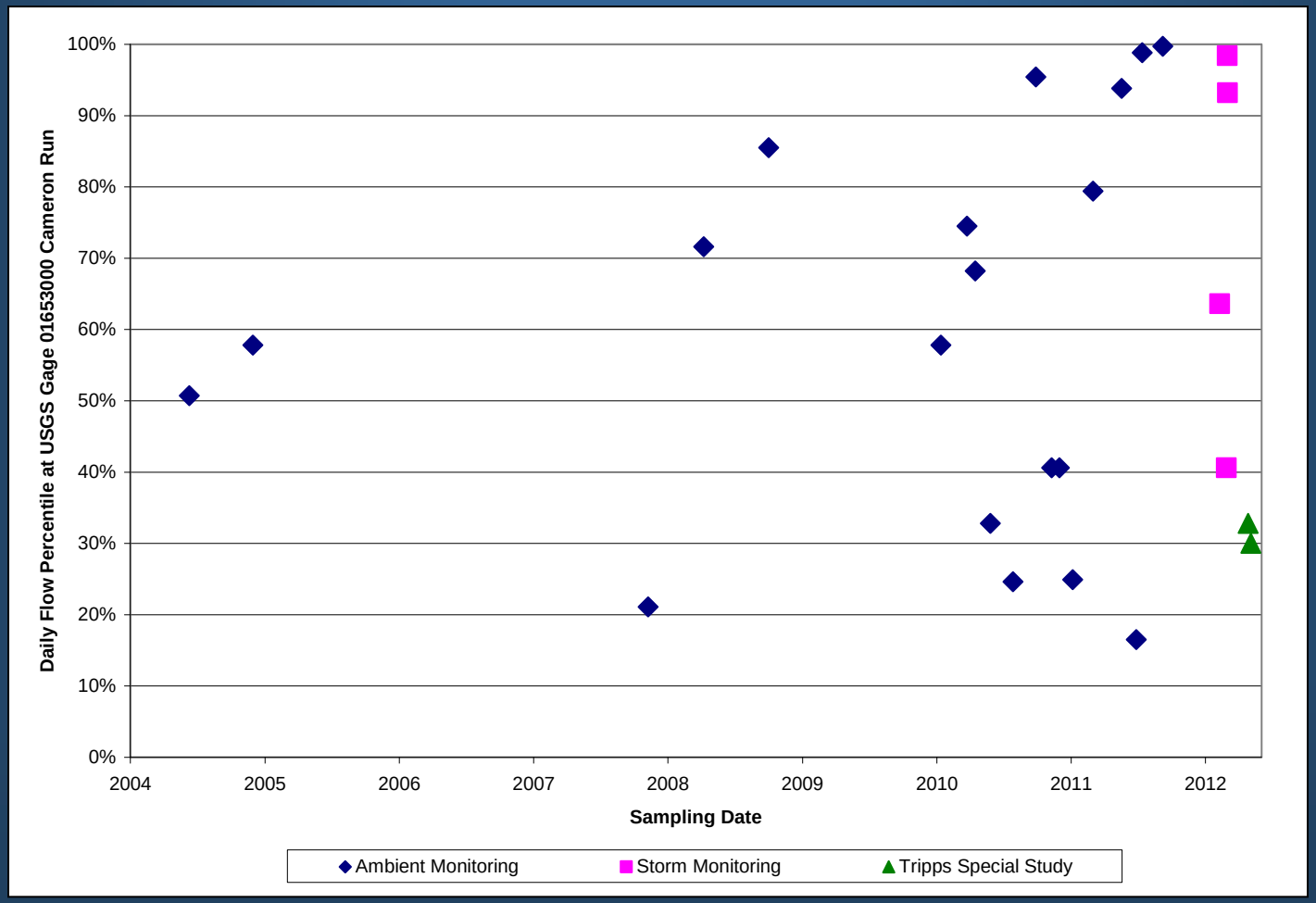
Constituent	Numerical Criteria
DO	>4 mg/l (instantaneous); >5 mg/l (daily average)
Temperature	< 32 C
pH	>6 and <9
Cl	860 mg/l (acute); 230 mg/l (chronic)
Metals	Various; in many cases applies to dissolved metals as a function of hardness
Ammonia	Function of pH (acute) or pH and temperature (chronic)

DEQ Monitoring Studies

- Ambient monitoring 2004-2012
- Biological monitoring and habitat assessment
- Storm monitoring (Four Samples in 2012)
- Two continuous monitoring samples in Holmes Run and one sample in Tripps Run
- Special study in Tripps Run (Two samples at four locations)

Fairfax County has also provided the results of their biological and water quality monitoring in Holmes Run and Tripps Run

Flow Conditions During Sampling



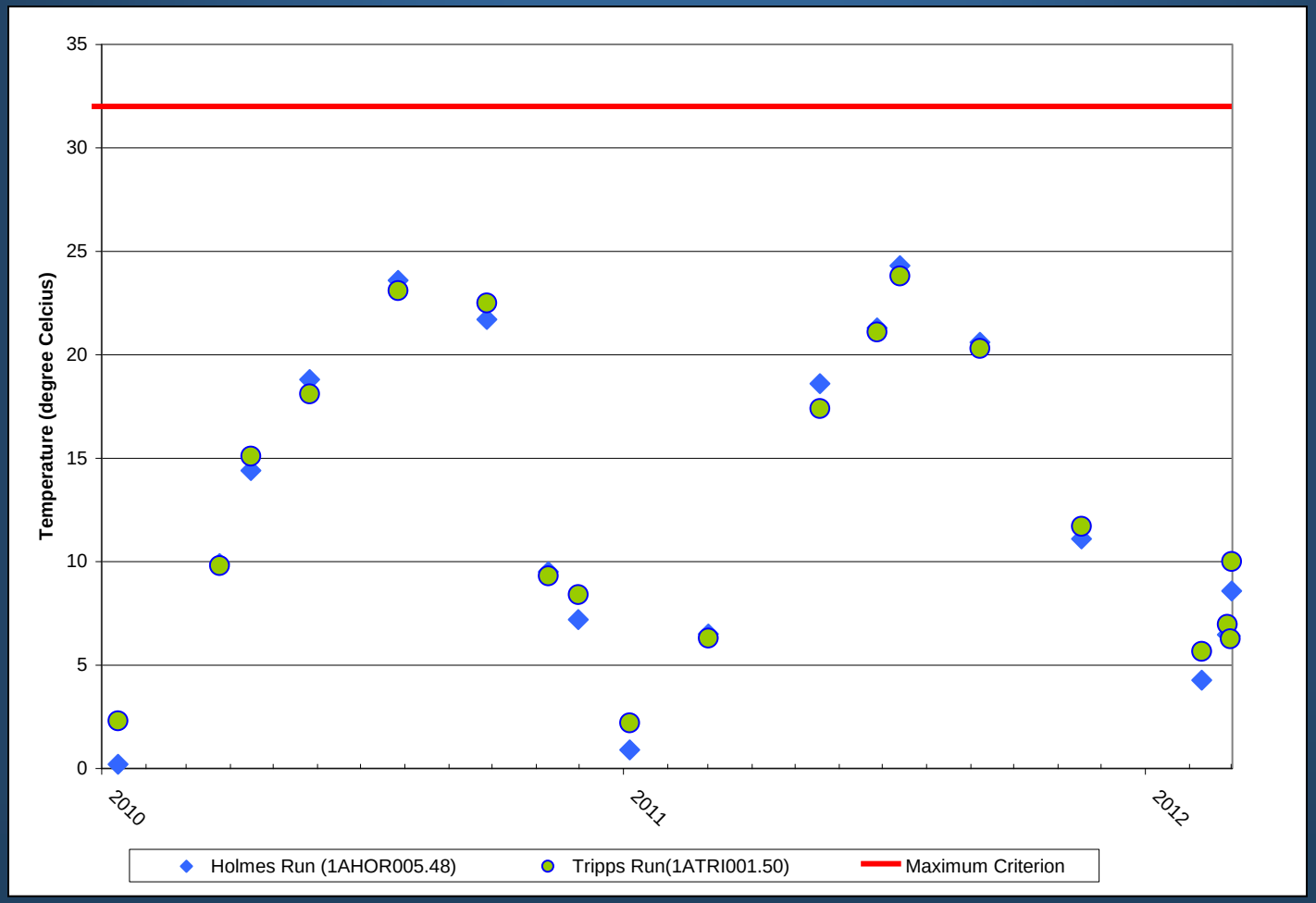
Number of Samples

Constituent	Holmes Run	Tripps Run
DO, pH, Temperature, Conductivity (Field)	24	26
Total Dissolved Solids	17	15
Chloride, Sulfate, Calcium, Sodium, Potassium, Beryllium	~17	~16
Nutrients: NH4, NO2, NO3,TKN, TP, PO4	19	18
Metals: Cadmium, Chromium, Copper, Lead, Silver, Nickel, Zinc	6 Total 3 Diss.	5 Total 2 Diss.
Benthic Macroinvertebrate/Habitat	7	7

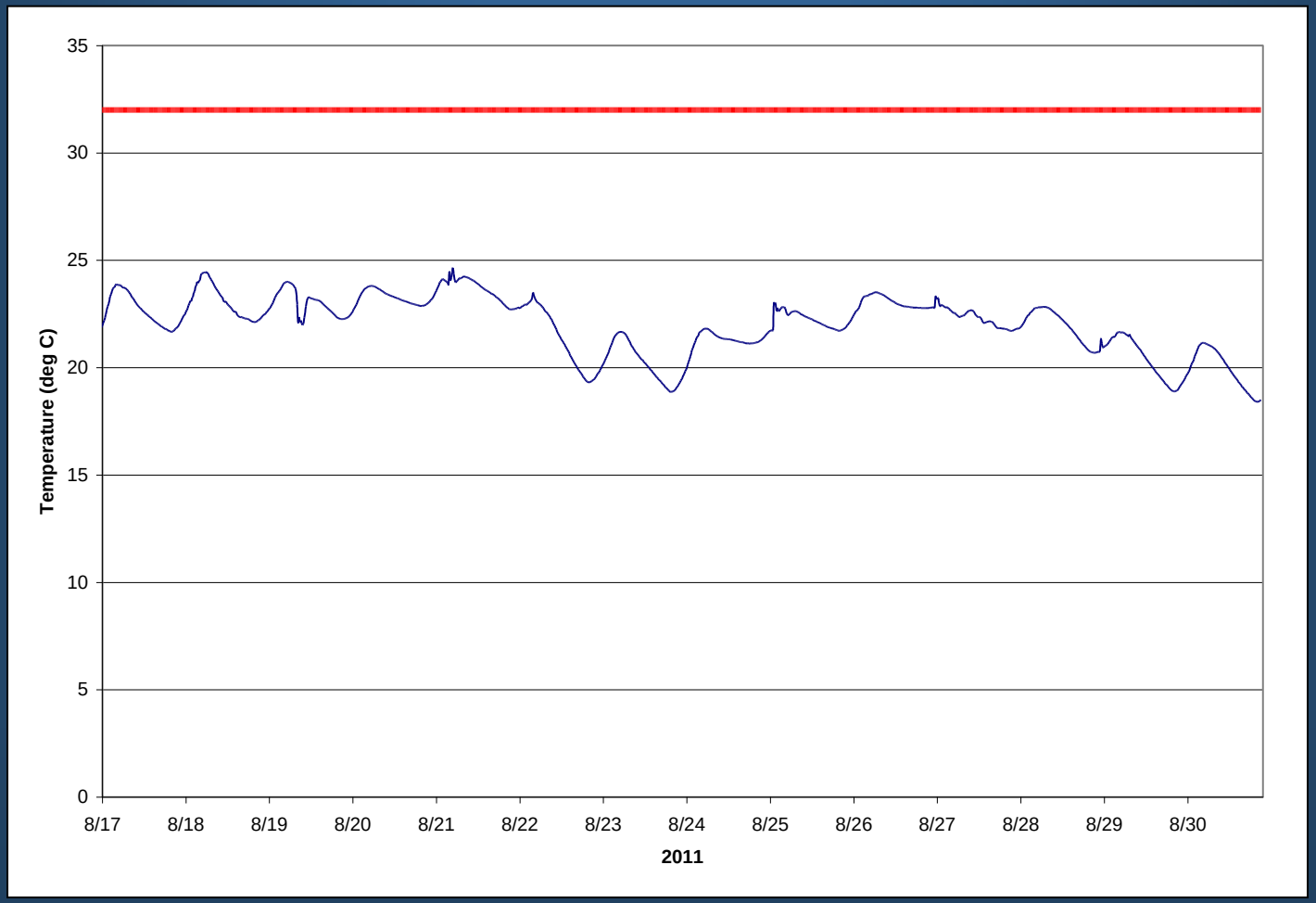
Temperature, pH, and DO

- Field measurements and continuous monitoring data
- No violations of VA standards observed
- Some evidence of large diurnal DO swings in continuous monitoring data

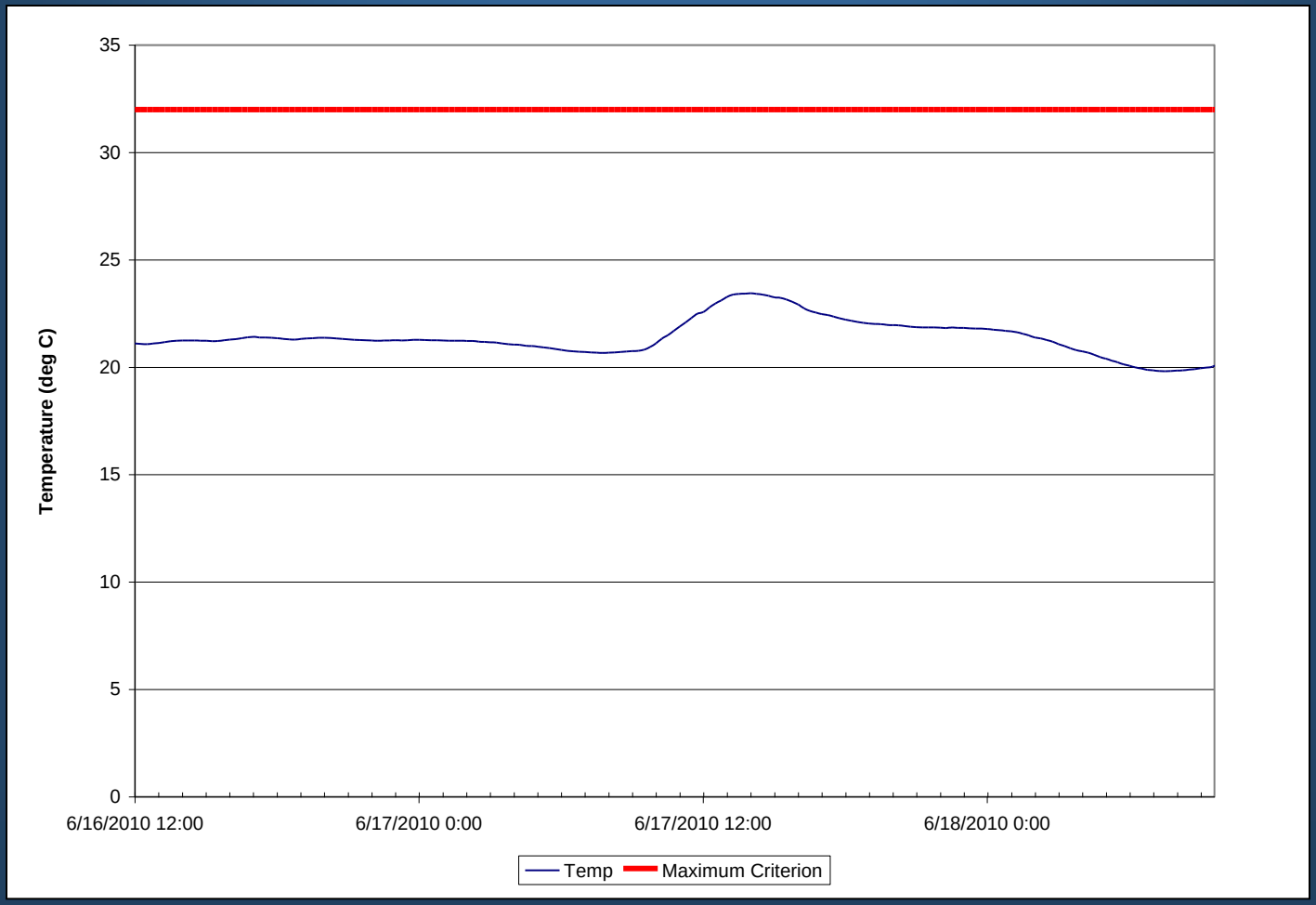
Temperature



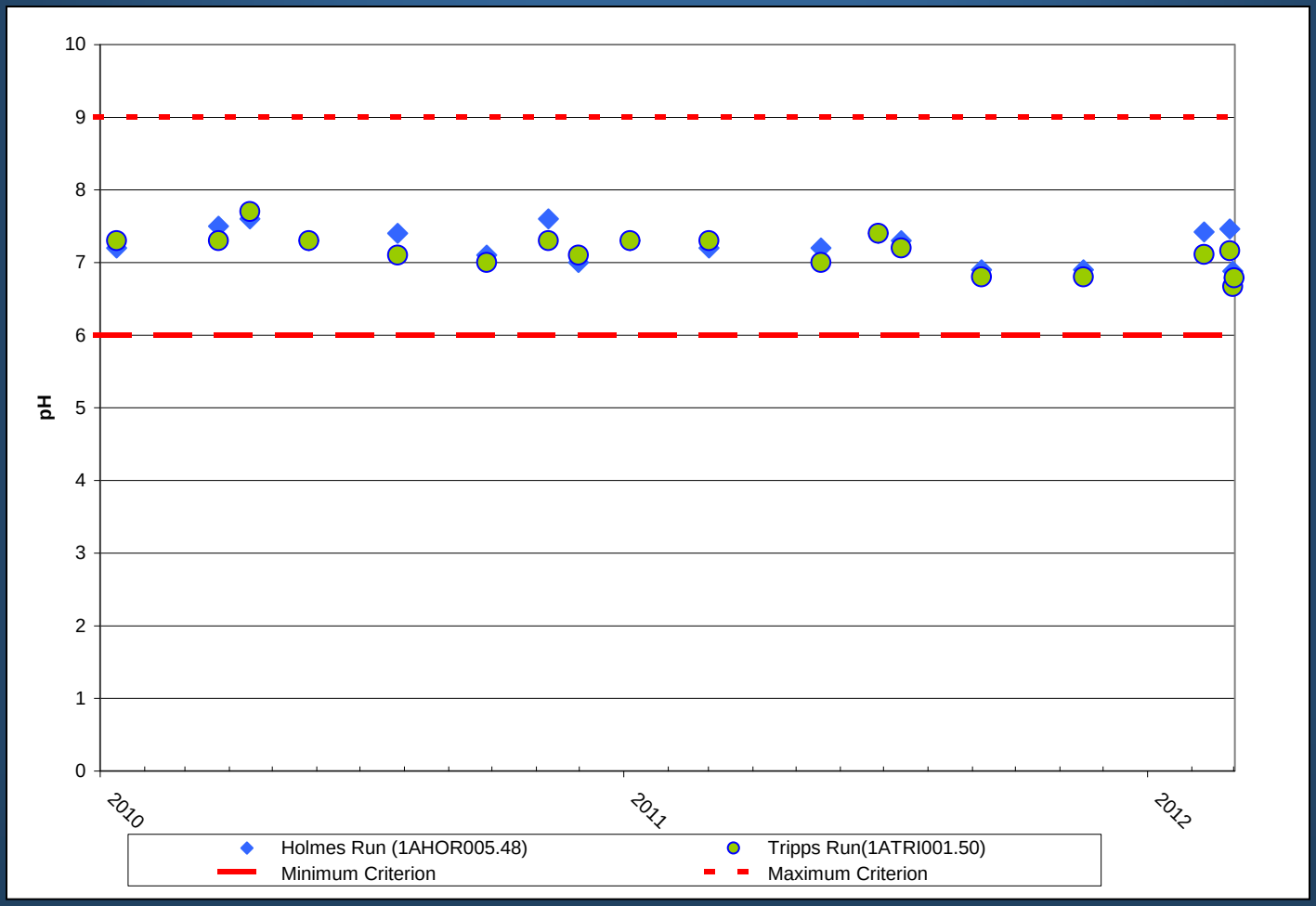
Temperature - Holmes Run



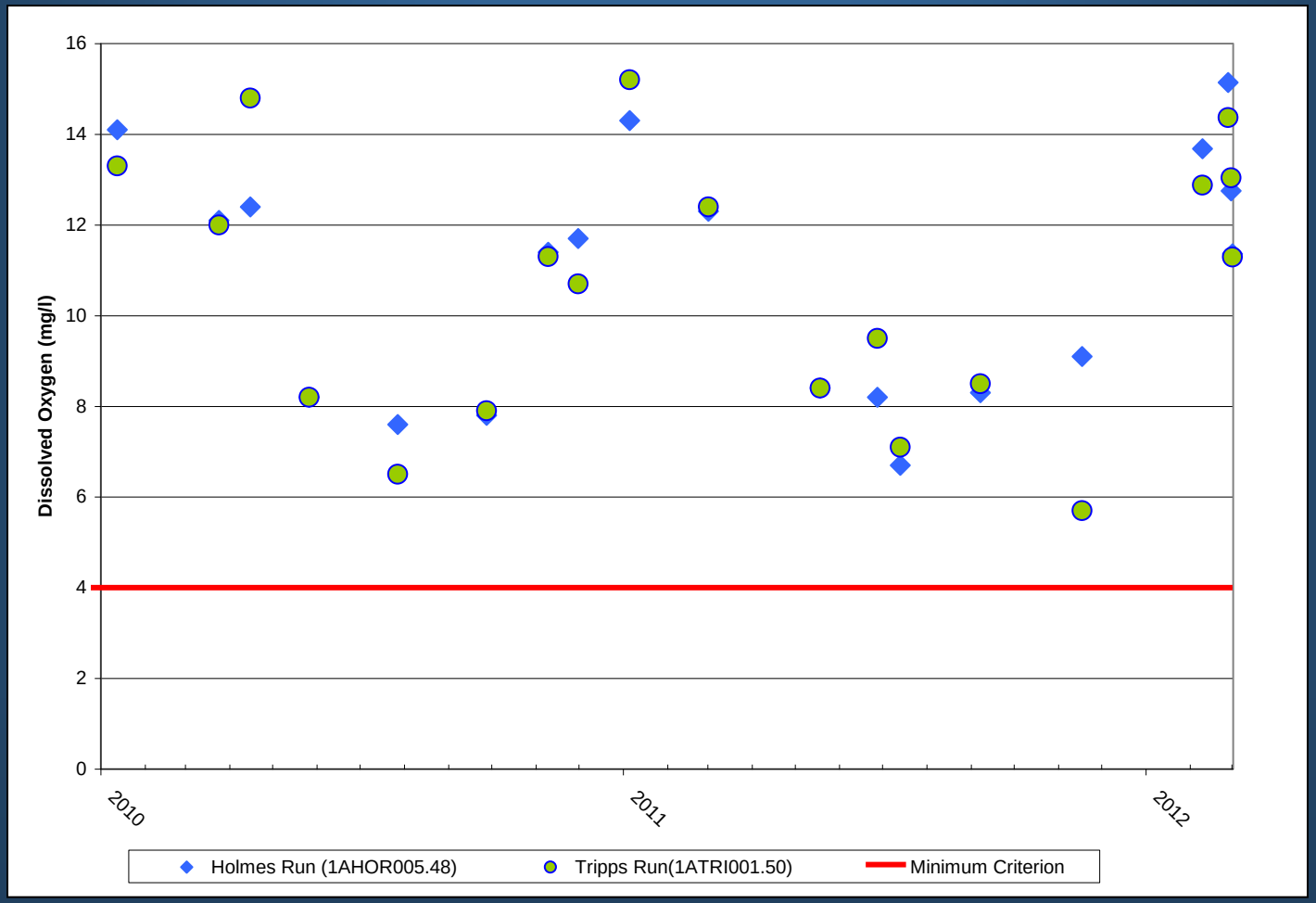
Temperature-Tripps Run



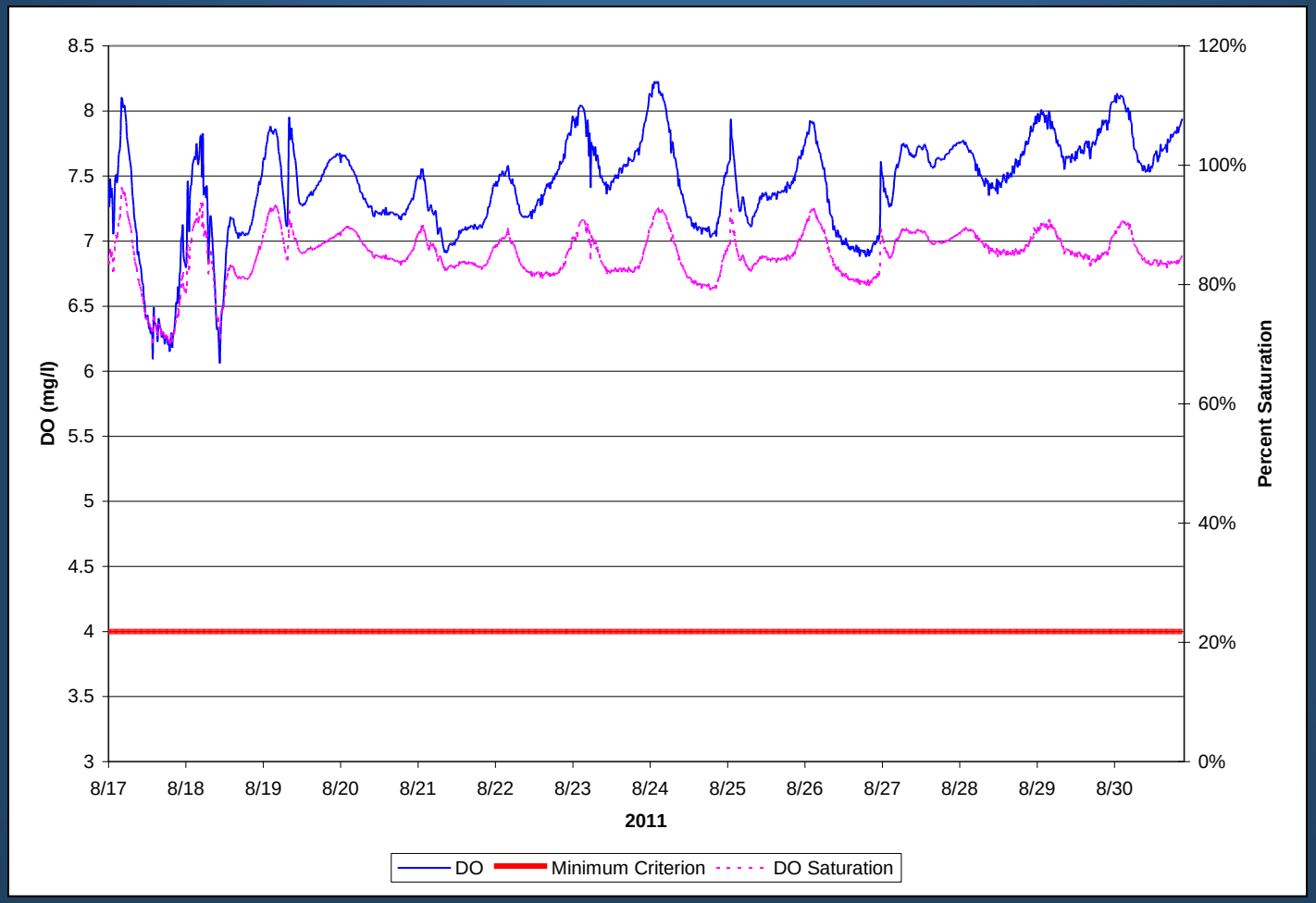
pH


10
9
8
7
6
5
4
3
2
1
0
pH
2010
2011
2012
Holmes Run (1AHOR005.48)
Tripps Run(1ATRI001.50)
Minimum Criterion
Maximum Criterion

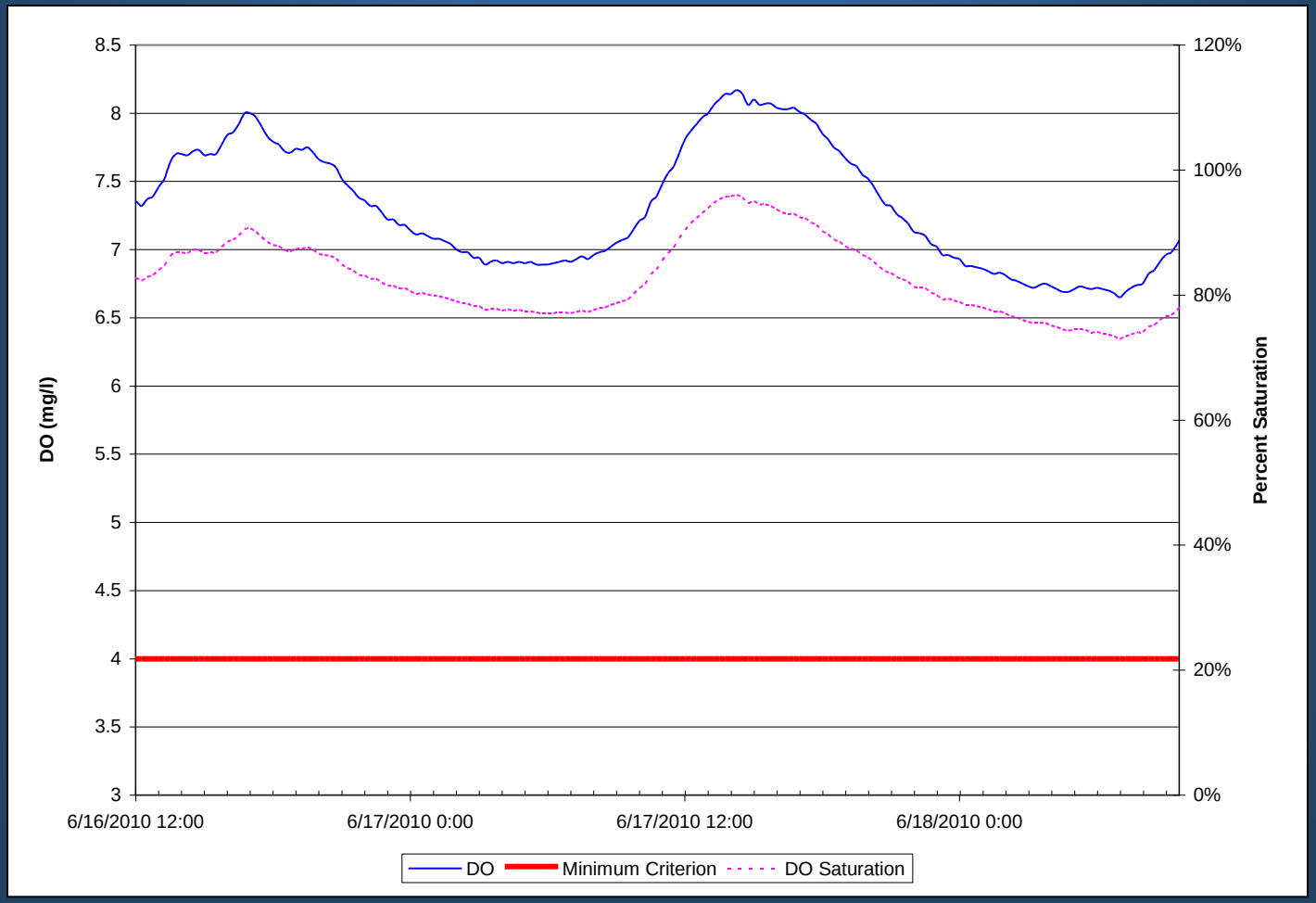
Dissolved Oxygen



DO-Holmes Run



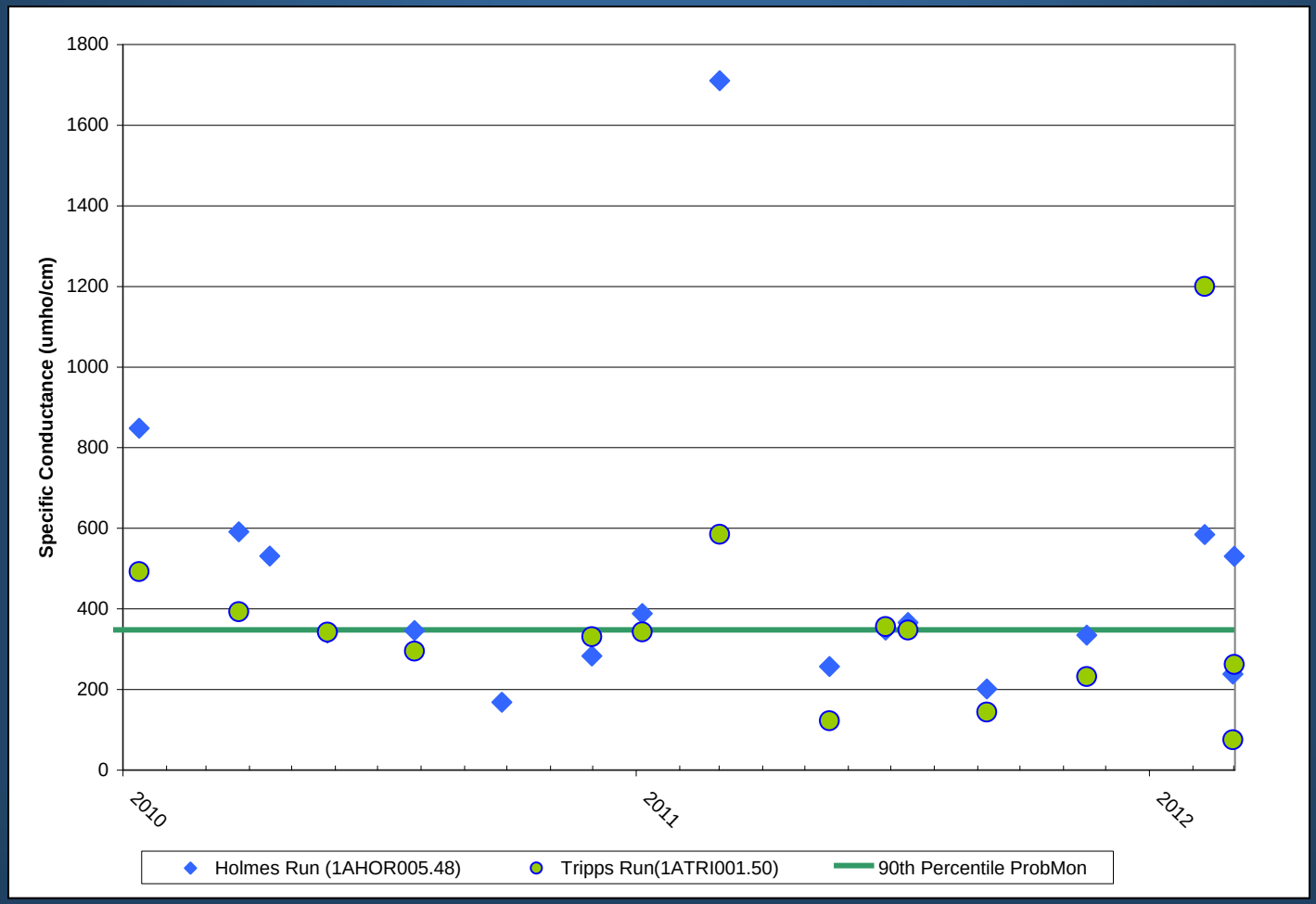
DO-Tripps Run



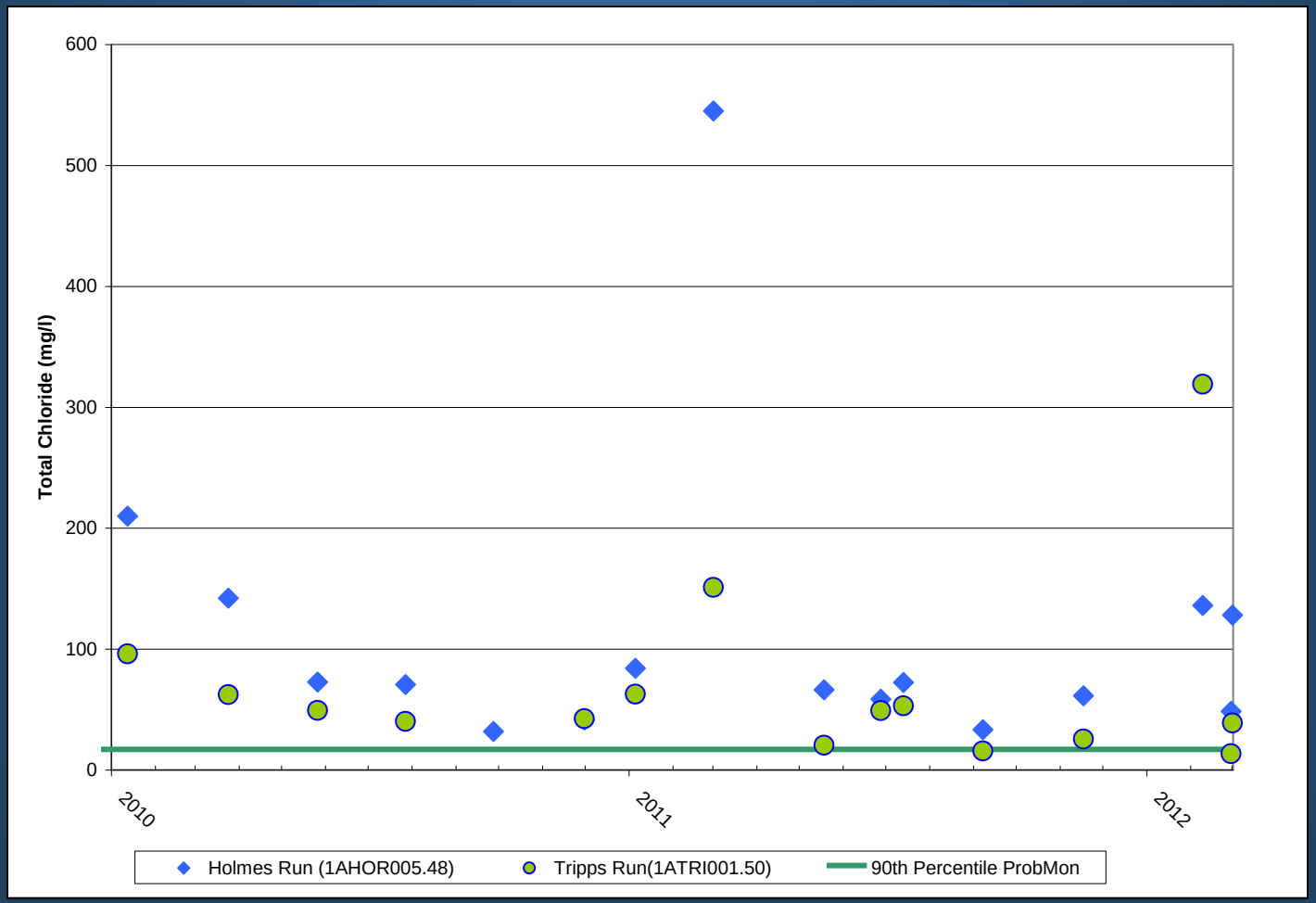
Conductivity, Chloride, and Dissolved Solids

- Conductivity, chloride, and TDS highly correlated
- No exceedances of VA chloride standard
- Concentrations are high relative to VA samples

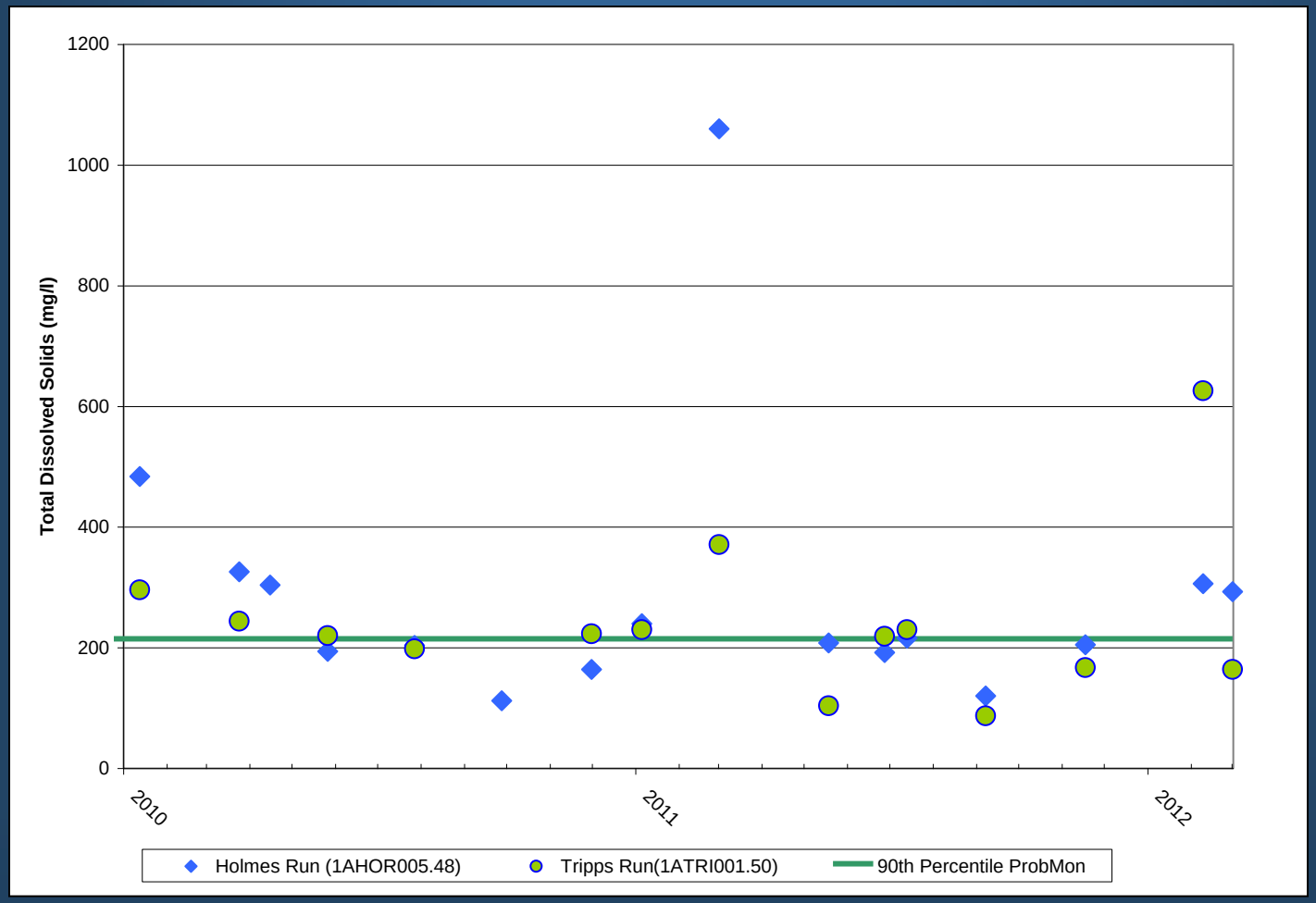
Specific Conductance



Total Chloride



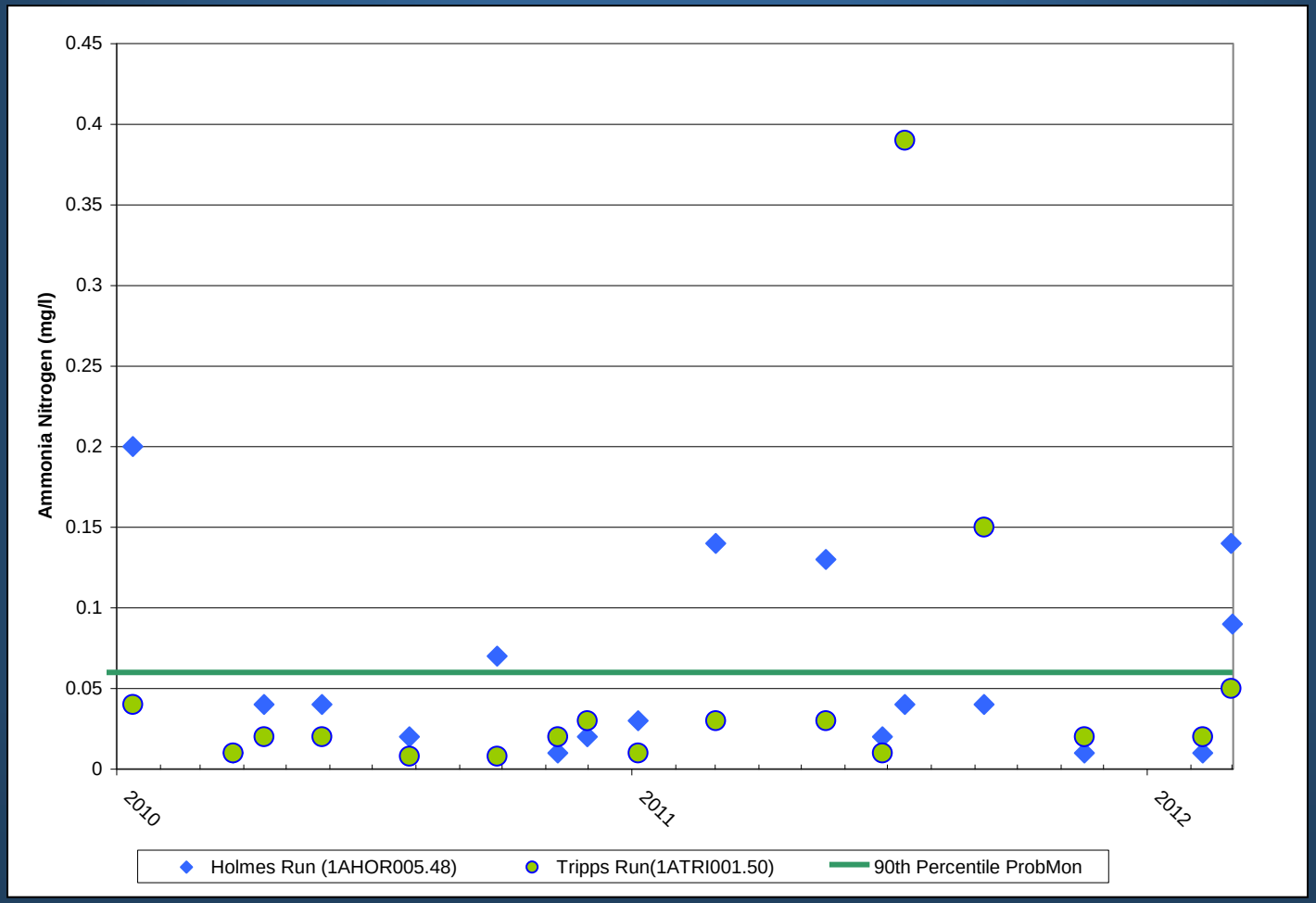
Total Dissolved Solids



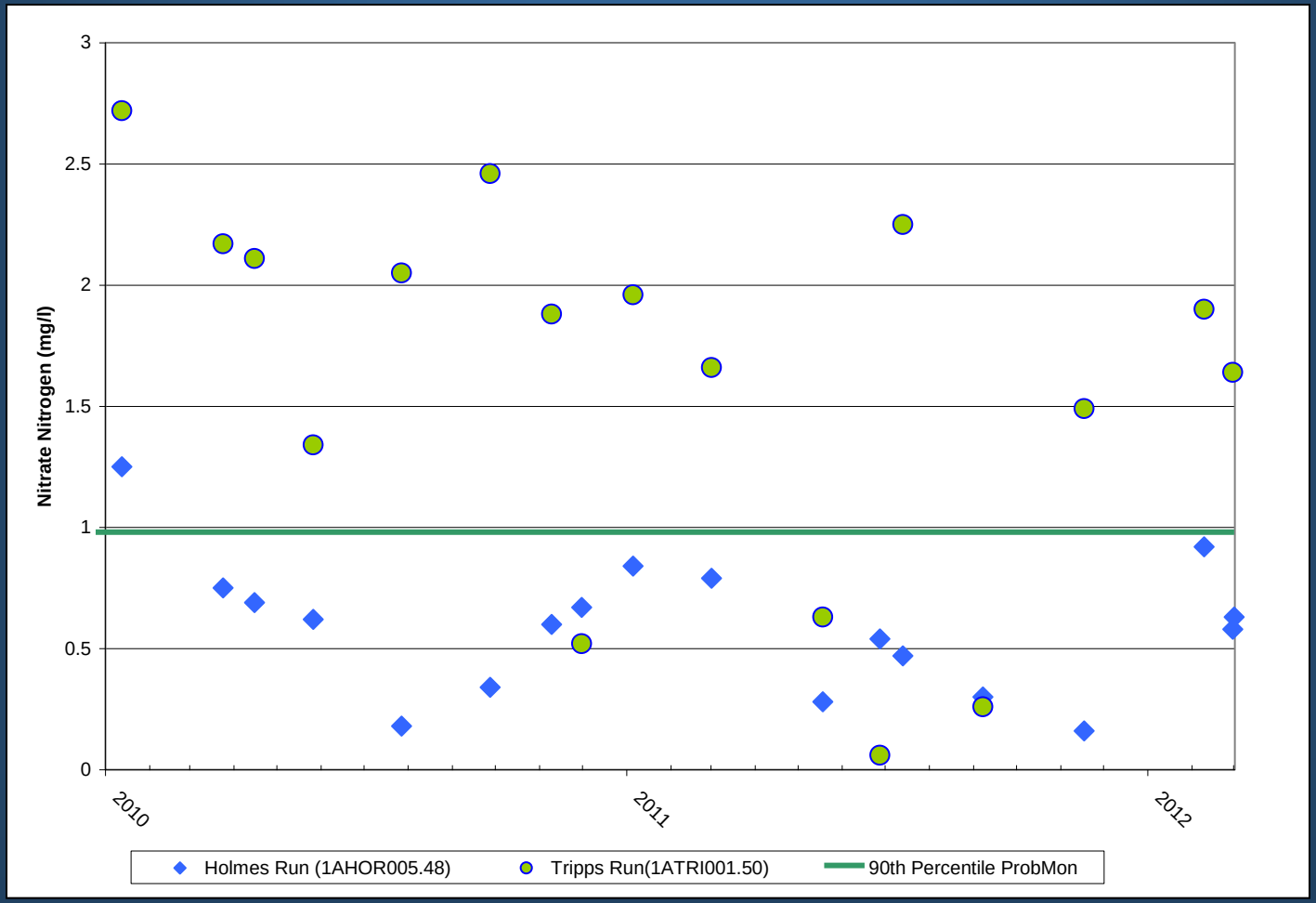
Nutrients

- No exceedances of ammonia criteria
- No other current VA numerical criteria for nutrients
- Nitrogen concentrations are high in both Holmes Run and Tripps Run
- Nitrate concentrations in Tripps Run unusually high

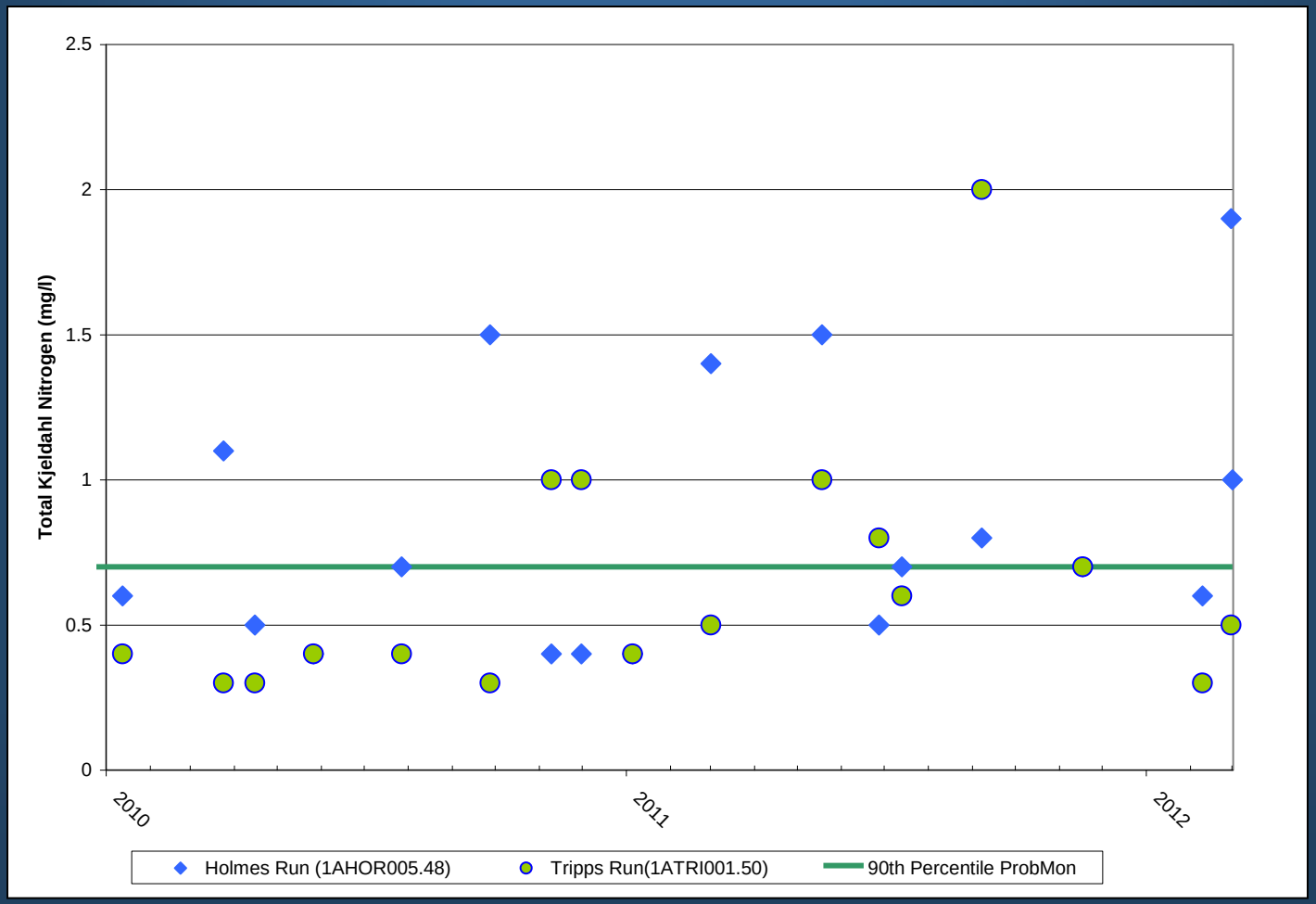
Ammonia


0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Ammonia Nitrogen (mg/l)
2010
2011
2012
Holmes Run (1AHOR005.48)
Tripps Run(1ATRI001.50)
90th Percentile ProbMon

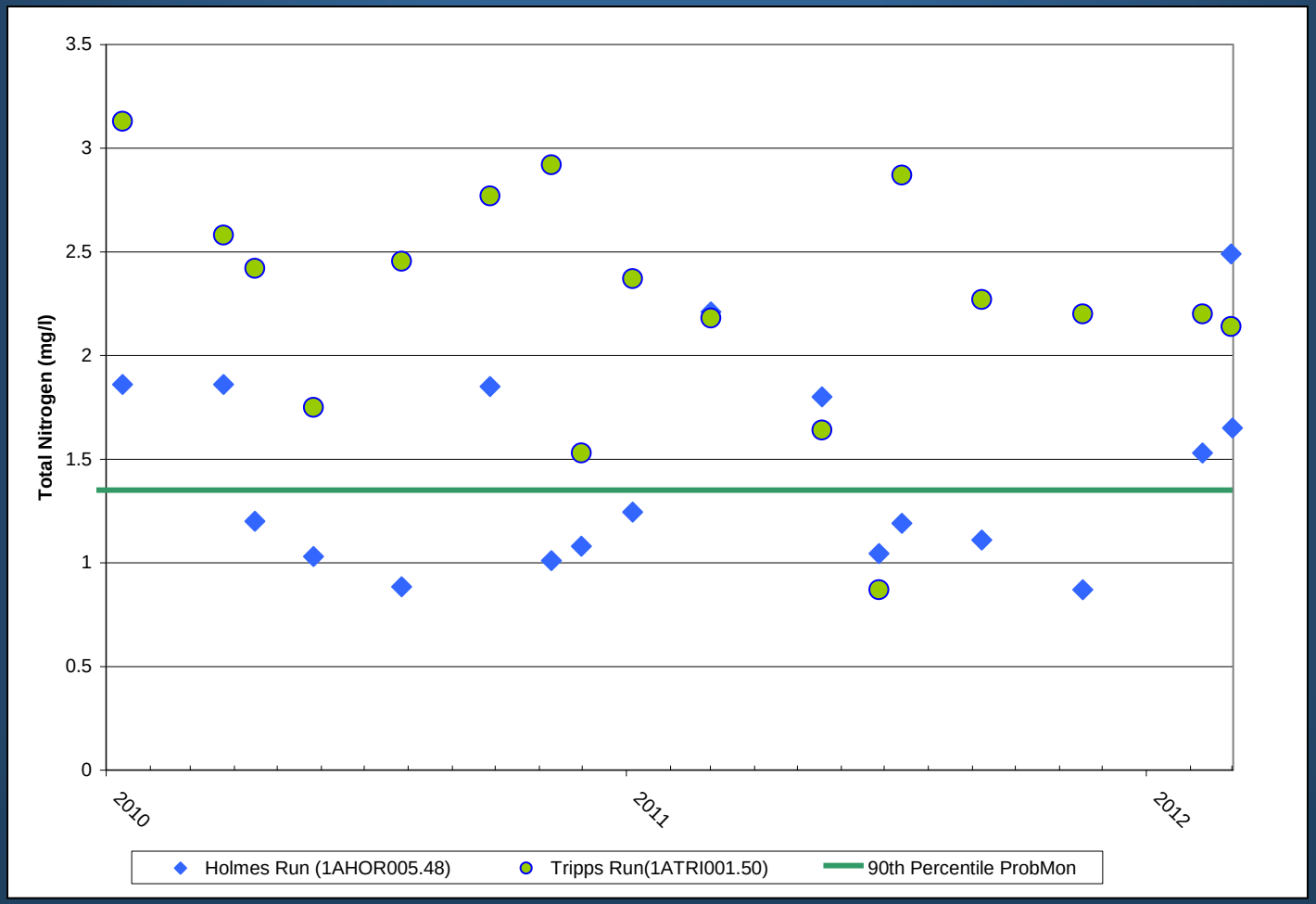
Nitrate


Nitrate Nitrogen (mg/l)
3
2.5
2
1.5
1
0.5
0
2010
2011
2012
Holmes Run (1AHOR005.48)
Tripps Run(1ATRI001.50)
90th Percentile ProbMon

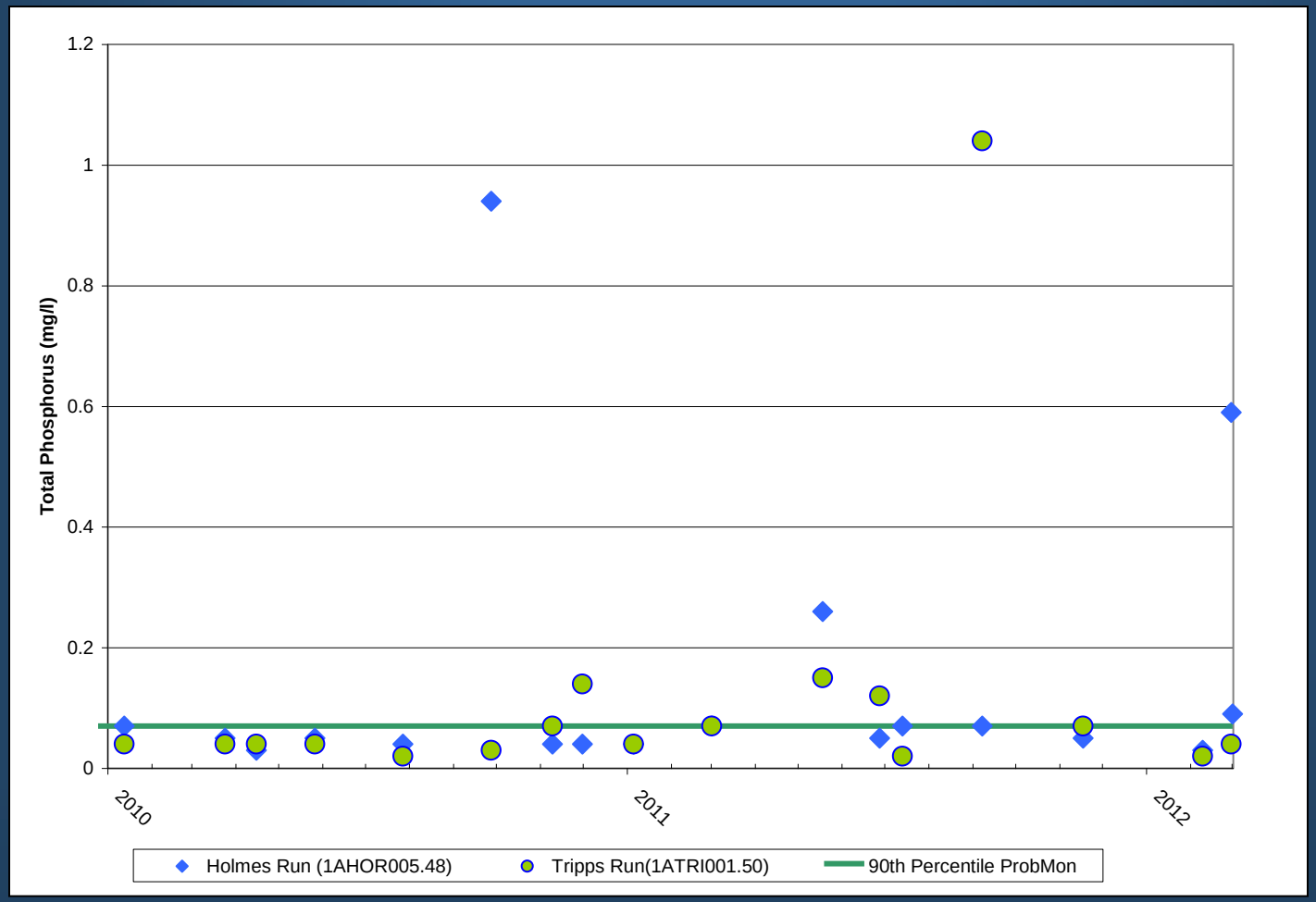
Total Kjeldahl Nitrogen



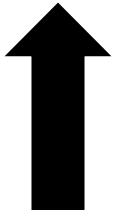
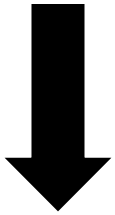
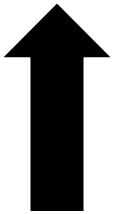
Total Nitrogen



Total Phosphorus



Flow Regimes and Concentration

Constituent	Base Flow	Storm Flow
NO3, Cl, TDS, Conductivity		
TP, TKN,TSS		

Metals

- No exceedances of VA criteria (based on dissolved metals)
- Only total metals were collected during storm events
  - No criteria for total metals
  - Total copper, nickel, lead, zinc did exceed VA criteria for dissolved metals during storm events

Toxicity Tests on Fathead Minnows (*Pimephales promelas*) and Water Fleas (*Ceriodaphnia dubia*)

- **No statistically significant effects on either fleas or minnows for Holmes Run treatments**

- **Sporadic mortality in minnows with Tripps Run treatments, but (1) no monotonic dose-response relation and (2) no effects on fleas suggest presence of fish pathogen, not chemical toxicants, is cause.**

Sediment

- Habitat Assessment
- Logged Relative Bed Stability (LRBS) Index

Habitat Assessment

- Median Embeddedness scores in marginal range (6-10) for both Holmes Run and Tripps Run
- Median Sediment Deposition scores in marginal range (6-10) for both Holmes Run and Tripps Run
- Median Bank Stability scores is sub-optimal range (11-15) for both Holmes Run and Tripps Run

Holmes Run Habitat Scores

Date	Total	ALTER	BANKS	BANK VEG	EMBED	FLOW	RIFFLES	RIP VEG	SEDIMENT	SUBSTRATE	VELOCITY
6/9/04	155	19	18	16	13	17	17	10	14	17	14
11/29/04	133	20	18	8	12	14	15	4	13	17	12
11/8/07	95	7	11	9	9	9	14	6	10	10	10
4/7/08	115	9	14	16	8	18	16	2	7	15	10
10/1/08	113	8	12	15	10	17	16	2	6	12	15
4/15/10	105	12	12	14	8	14	14	7	7	8	9
11/9/10	93	11	13	13	6	8	12	4	6	8	12
Median	**113**	**11**	**13**	**14**	**9**	**14**	**15**	**4**	**7**	**12**	**12**

Marginal or Poor

Tripps Run Habitat Scores

Date	Total	ALTER	BANKS	BANK VEG	EMBED	FLOW	RIFFLES	RIP VEG	SEDIMENT	SUBSTRATE	VELOCITY
6/9/04	151	19	18	18	10	18	16	8	13	17	14
11/29/04	140	20	18	14	9	17	15	4	13	17	13
9/25/07	116	15	12	13	12	6	15	13	12	8	10
4/7/08	117	13	12	14	5	14	16	13	6	14	10
10/1/08	108	15	10	13	8	14	15	9	4	6	14
4/15/10	133	16	16	16	8	13	14	14	10	13	13
11/9/10	102	13	6	8	7	10	15	14	8	8	13
Median	**117**	**15**	**12**	**14**	**8**	**14**	**15**	**13**	**10**	**13**	**13**

Marginal or Poor

Relative Bed Stability Index

- Field measurements: channel slope, hydraulic radius, geometric mean (median) particle size (D_{50})
- Calculate: Maximum particle diameter transported at bankfull flow (D_{cbf})~ slope, radius
- LRBS ratio: $\log_{10}$ (D_{50}/ D_{cbf}), measure of bed stability

LRBS

Stable Bed Conditions	**>-0.5**
Excessive Sediment Load	**< -1.0**
Holmes Run	**0.236**
Tripps Run	**0.208**

Hydro-Modification

- Tripps Run is 30% impervious and Holmes Run 25% impervious
- Tripps Run mostly channelized or piped above Annandale Road
- Biological monitoring shows low sample counts and elevated proportion of clingers
- Urban Stream Characteristics
  - Flashier flows
  - Channel alterations
  - Increase in concentrations of nutrients and contaminants
  - Reduced biological diversity and increase in tolerant species

Questions for Discussion

1. Are elevated nutrient concentrations impacting the biota?
2. What are the sources and transport paths for nitrates, TDS, Cl, and conductivity?
3. How should impacts of hydro-modification be addressed?
4. Can sediment negatively impact the biota even if streams are stable?
5. How can benthic TMDLs in urban environments account for multiple stressors?
6. What is the role of TMDLs in the “cure” for urban streams?

Questions?

What happens next?

1. **Comment Period for Materials Presented at the TAC Meeting:**

   May 24, 2012 to June 25, 2012

   Comments should be submitted in writing to:

   Jennifer Carlson
   jennifer.carlson@deq.virginia.gov
   13901 Crown Court, Woodbridge, VA 22193

2. **Public Meeting:**

   Thursday, May 31, 2012
   6:30 p.m. – 8:30 p.m.
   Woodrow Wilson Library
   Meeting Room 1
   6101 Knollwood Drive, Falls Church, VA 22041

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