Bacteria Source Investigation in an Urban Watershed

DNA Sleuthing in Four Mile Run

Don Waye
Northern Virginia Regional Commission
December 14, 2000

Why Study Four Mile Run Bacteria?

- Five separate organizations have found high bacteria levels in Four Mile Run
- Bacteria standard delimits acceptable human health list
- CWA mandates all "waters of the U.S." to be "fishable & swimmable"
- Four Mile Run (& 100s more) is on the State's 303(d) list of officially "impaired waters"
- TMDL deadline is looming (by 2010 or earlier)

NVPDC/NVRC Answered the Call

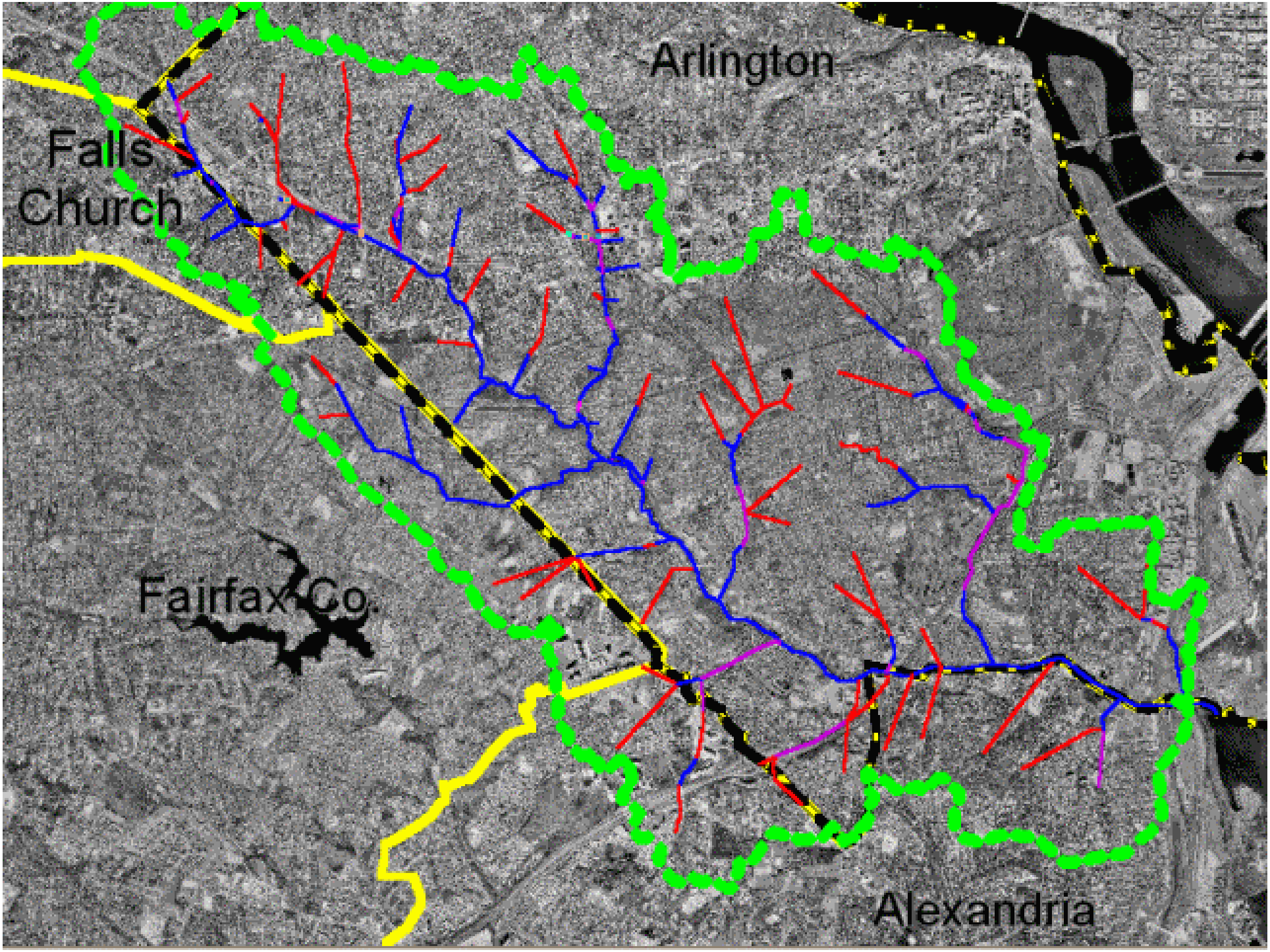
- Applied for (and awarded) State grant
- All 4 watershed localities provided additional funding
- Contracted with Dr. Simmons (VT) to apply the tools of modern molecular genetics to track down bacteria sources

Purpose

- To address public concern
- To formulate appropriate mitigation strategies
- To allow good science to precede good policy
- To prepare for TMDL

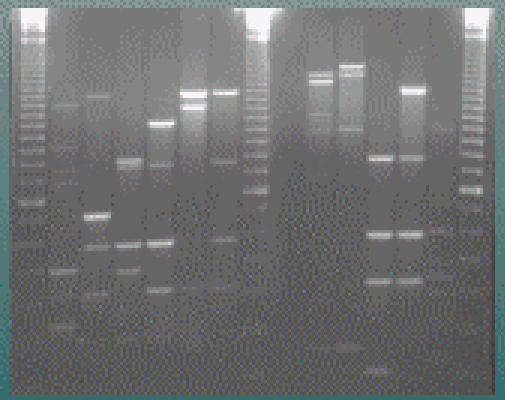
Timeline

- Phase 1: July 1999 - January 2001

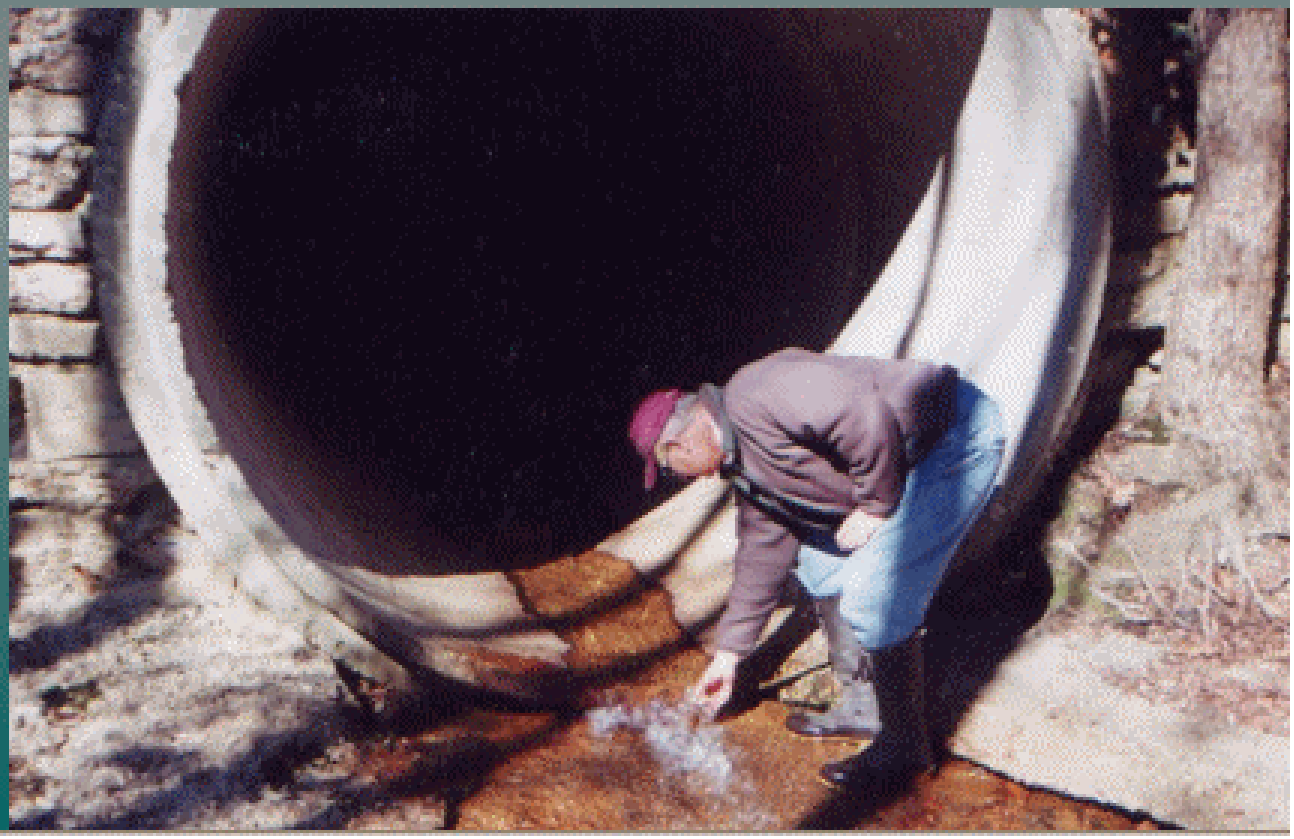

Arlington
Falls
Church
Fairfax Co.
Alexandria

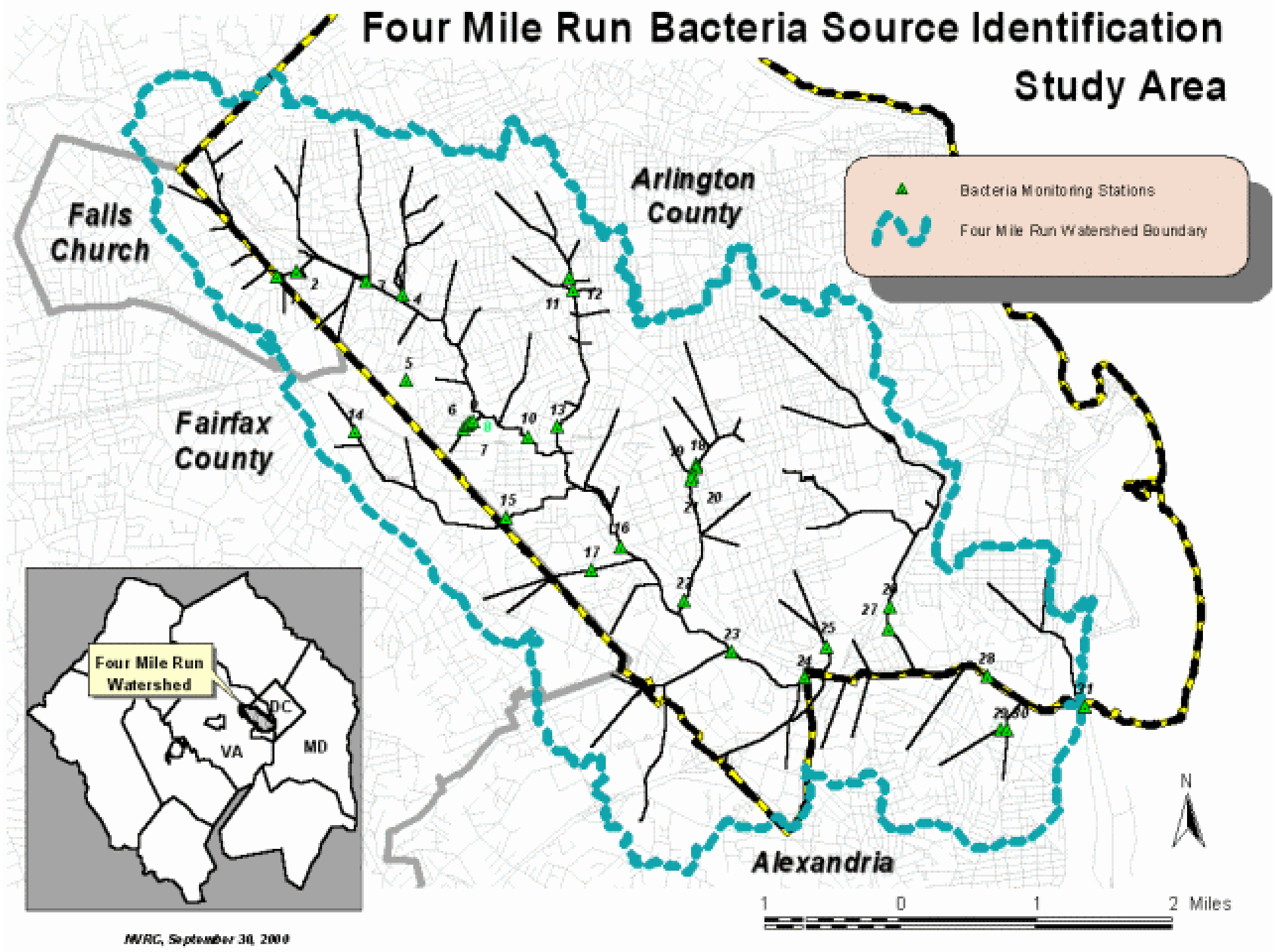
Bacteria Source Identification Using DNA Fingerprinting

- Dr. George Simmons pioneered this technique with work in Virginia's Eastern Shore
- *E. coli*-specific testing



- PFGE DNA profiling (like barcoding)




Four Mile Run Bacteria Source Identification Study Area
Falls Church
Arlington County
Fairfax County
Alexandria
Bacteria Monitoring Stations
Four Mile Run Watershed Boundary
Four Mile Run Watershed
DC
VA
MD
N
1 0 1 2 Miles
NVRC, September 30, 2009

Urban Wildlife in Four Mile Run

- humans *
- dogs *
- cats *
- raccoons *
- Canada Geese *
- Mallard Ducks *
- other ducks
- pigeons
- seagulls *
- gray squirrels *
- opossum *
- rats *
- beavers
- mice
- shrews
- bats
- deer
- rabbits
- flying squirrels *
- foxes *
- groundhogs
- muskrats

Project-specific DNA scat library included 54 samples representing 12 species*

Rogues Gallery of Bacteria Sources

Dogs At ~800 per square mile, dogs contribute over 5000 pounds of pet droppings each day to the 20 square mile Four Mile Run watershed.

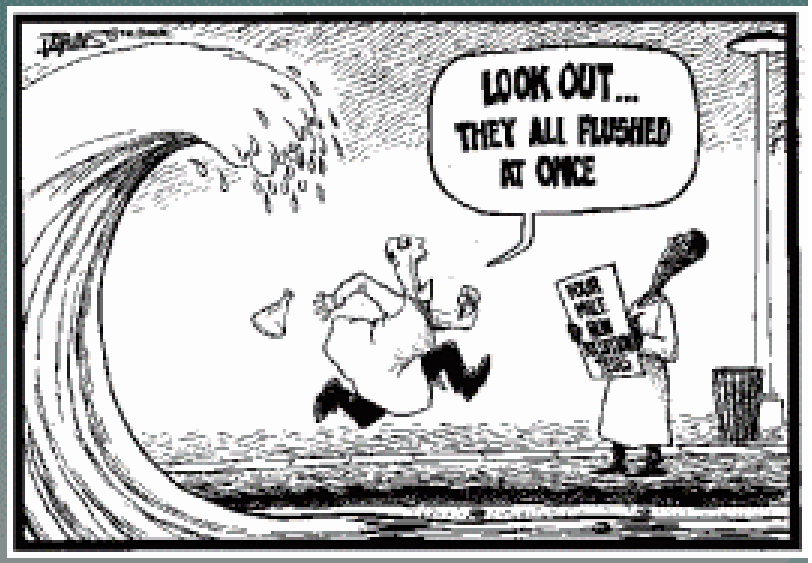
Cats In several comparable MST studies of urban/suburban stream systems, cats have been implicated in roughly the same degree as dogs.

Canada Geese Populations of the non-migratory race of this large waterfowl have exploded in recent years.

Rogues Gallery (cont.)

Humans

Although the watershed has a separate sewer system, illicit discharges are discovered from time to time. (Homeless population adds a wildcard factor)



Raccoons

Population densities of this adaptive nocturnal mammal are an order of magnitude greater in urban settings than in the wild. They are known to use storm drain networks as their own "Intelligent Transportation System" to move from greenspace to greenspace.

Pictorial Tour of Bacteria

Microbial puddles during drought of Summer 1999

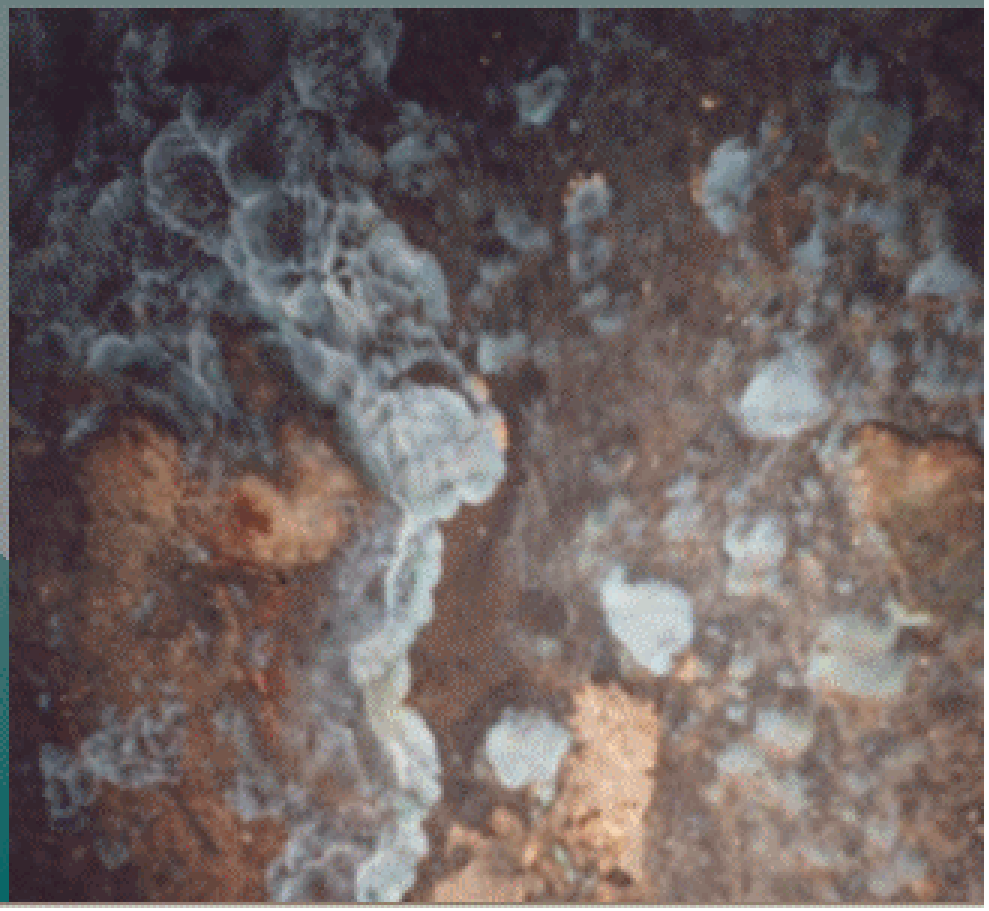
Iron-fixing bacteria is orange

Bacteria colonies often appear as a surface sheen, slightly iridescent in blue-gray spectrum.

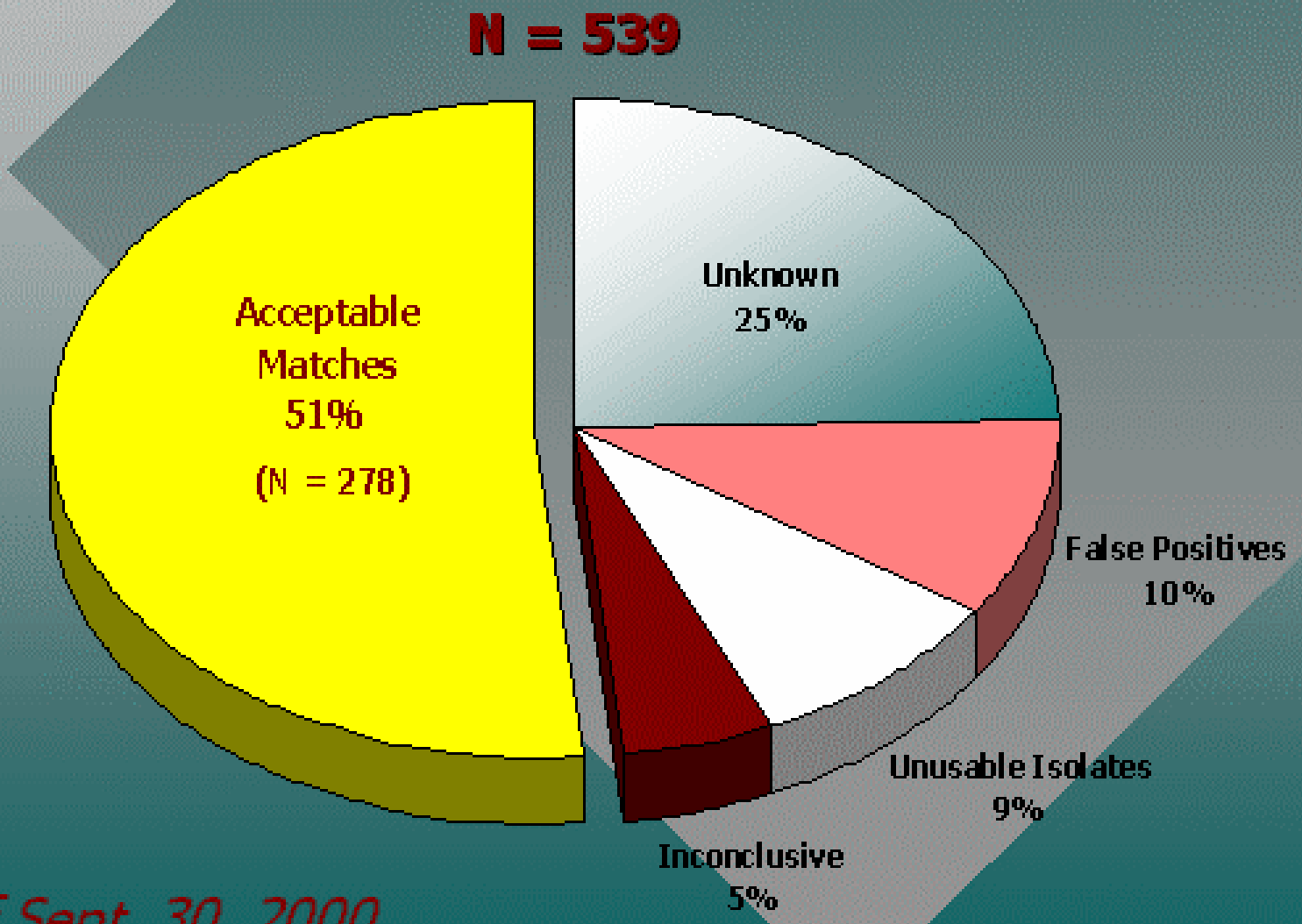
Ballston Beaver Pond in Arlington

Mystery "clouds" of organic-rich proteins or lipids in the sewers downstream of Ballston Beaver Pond

Detail



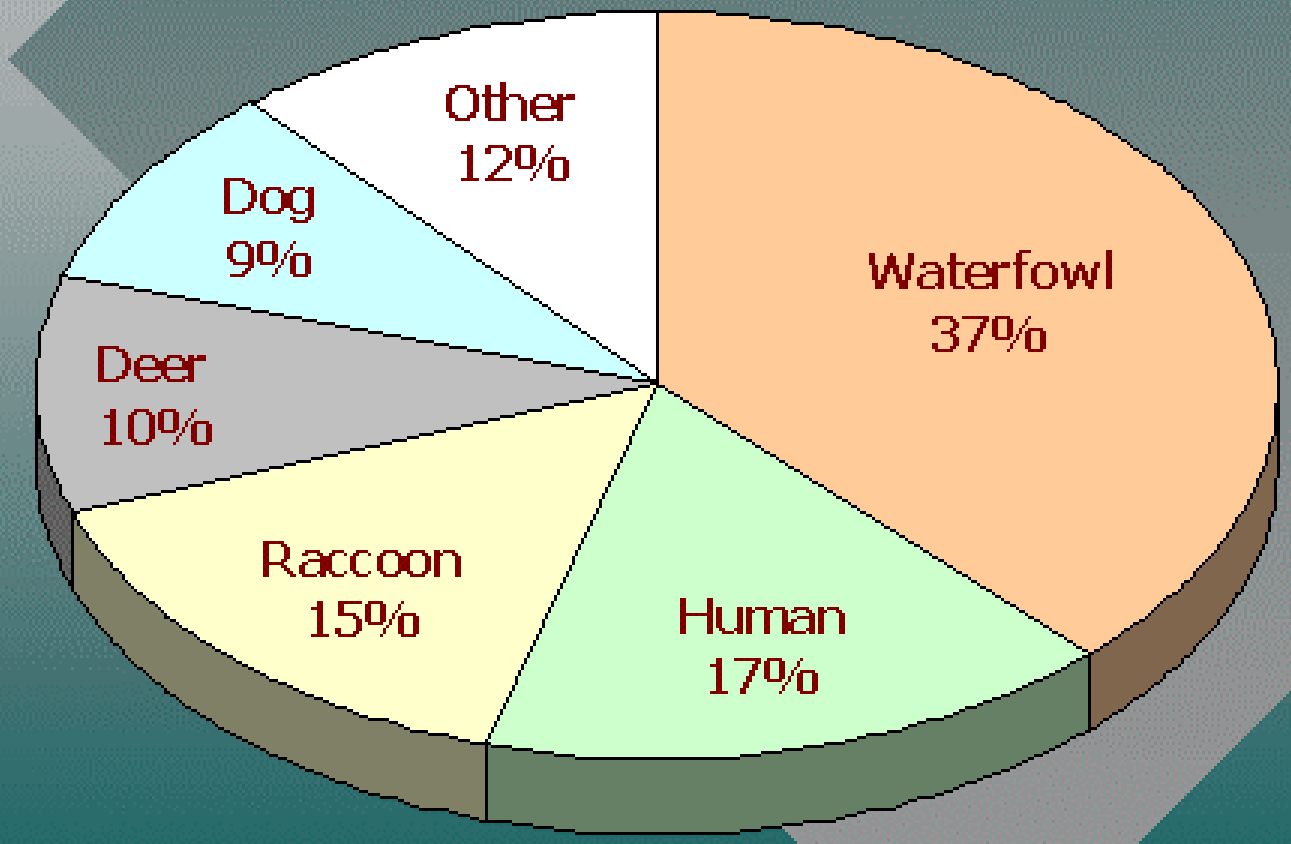
Success of Isolate Matching *



*as of Sept. 30, 2000

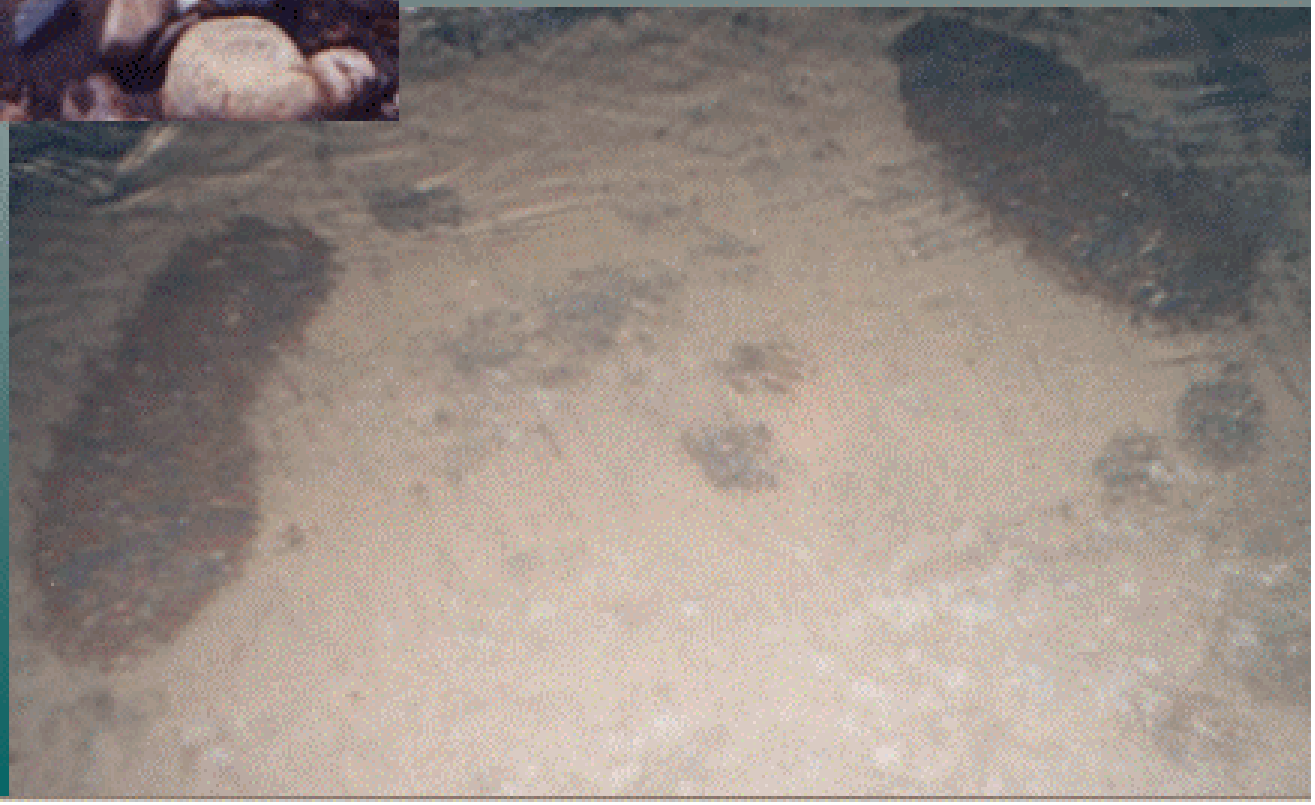
Isolates by "Probable" Species*

N = 278



*as of Sept. 30, 2000

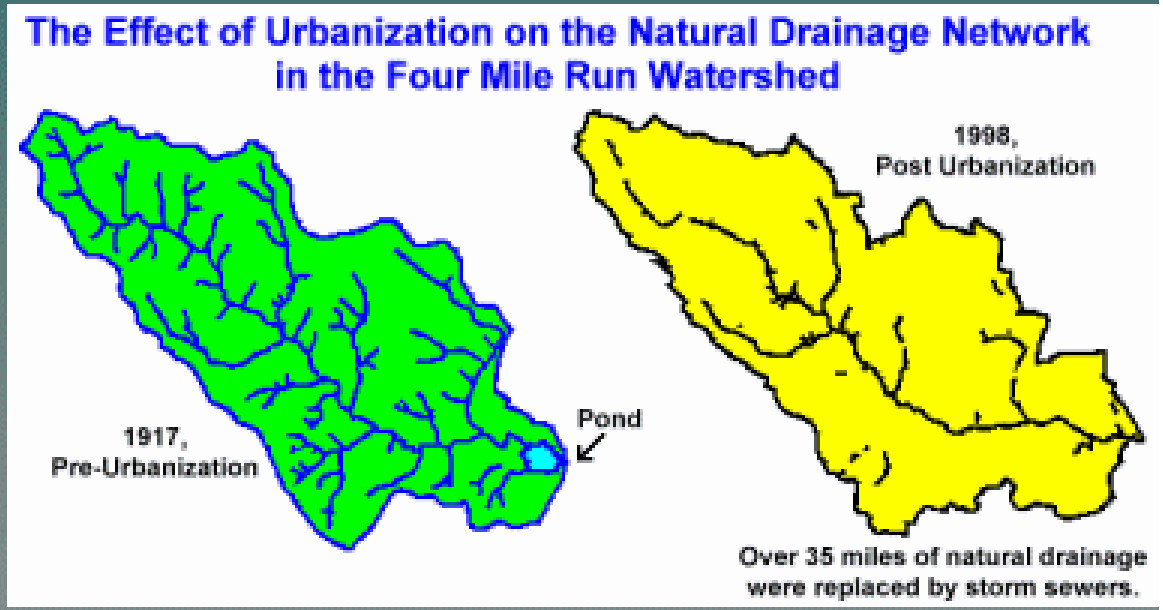
Raccoon tracks in sewers (bottom) and silt bar next to sewer in Four Mile Run



Raccoon scat in the sewers of Four Mile Run

Conclusions

- Storm drains and sediments (& scour pools?) seem to promote regrowth of bacteria



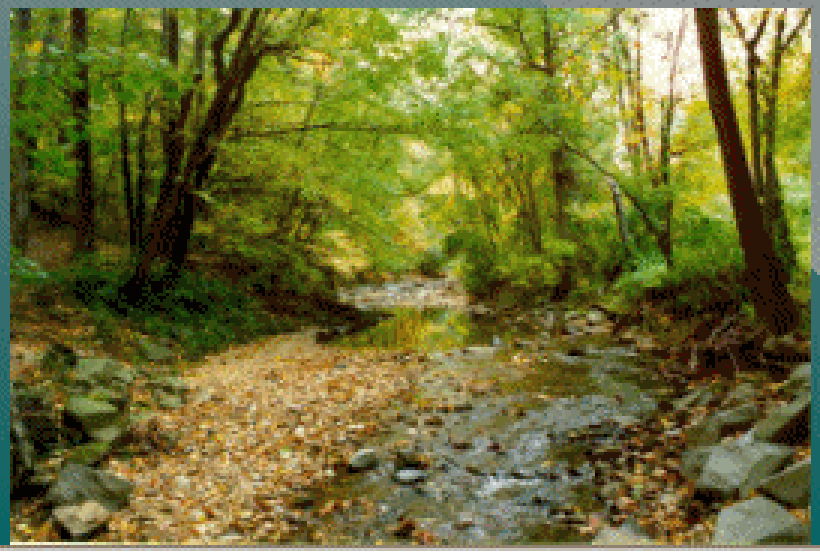
- Lack of matches with species absent in watershed fosters confidence in technique
- DNA work confirms low microbial biodiversity (large population of *E. coli* clones)
- Waterfowl, humans, raccoons, and dogs seem to be the significant sources

Why Suggest Regrowth?

- Occum's Razor—the simplest answer that fits the data
- Highest bacteria counts from storm drain outfalls and sediments
- Need more comparative data on bacteria strain variability (e.g., paired watershed study)

Ways to Kill or Reduce Bacteria

- Restore conditions to encourage bacteria predation from other microbes like paramecium and rotifers
- Go after the sources (e.g., "GeesePeace"-type solutions for waterfowl droppings, control pet waste, block raccoon ledges in storm drains)
- UV light exposure (natural or artificial)

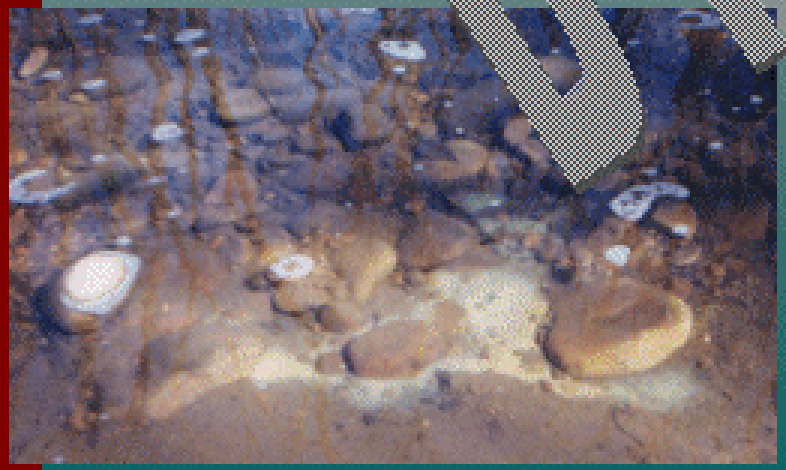


Theoretical Ways; Not Recommended

Recommended Approach

Short term:

- Track down illicit connections with Optical Brightener Monitoring and other tools
- Enforce pooper scooper laws
- Clean out catchbasins
- Investigate benefits of high efficiency street sweeping



- Investigate associations with scour pools and sunlight exposure (continue research)

Recommended Approach*

Long-term:

- Restore conditions to encourage bacteria predation from other microbes like paramecium and rotifers
- go after animal sources of bacteria
- dissuade raccoons from using storm drains as toilets (e.g., remove ledges)
- oral contraceptives for raccoons (being developed to fight spread of rabies) ?!
- promote storm drain daylighting (very long term!)

*For discussion purposes

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Don Waye
Northern Virginia Regional Commission
December 14, 2000

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 72D AIR BASE WING (AFMC)
TINKER AIR FORCE BASE OKLAHOMA

31 Aug 2006

MEMORANDUM FOR DIANE SMITH
ENVIRONMENTAL PROTECTION SPECIALIST
WATER QUALITY PROTECTION DIVISION
ENVIRONMENTAL PROTECTION AGENCY REGION 6
1445 ROSS AVE
DALLAS, TEXAS 75202-2733

FROM: 72 ABW/CEV
7701 Arnold Street, Suite 204
Tinker AFB, OK 73145-9100

SUBJECT: Comments, Canadian River Total Maximum Daily Load

1. This memorandum constitutes Tinker Air Force Base's (Tinker AFB) initial comments on the Canadian River total maximum daily load (TMDL), including all of the tributaries of the Canadian River. For the reasons set forth below, Tinker is opposed to the Canadian River TMDL, the use anywhere in Oklahoma of the load duration curve as the basis, in whole or in part, for setting bacteria reduction levels, and to the process and procedures EPA is using in setting the Canadian River TMDL.

2. Although the Canadian River TMDL does not directly impact Tinker, we are very concerned due to the method used to develop it and the process EPA is using to establish the Canadian River TMDL.

3. Parsons prepared a draft report titled "Bacterial Total Maximum Daily Loads for Canadian River, Oklahoma (OKWBID 52062)" for the Oklahoma Department of Environmental Quality (ODEQ) (the Canadian River Report). The Canadian River Report uses the load duration curve method ("LDC method") as the principle basis for establishing TMDL reduction calculations. Parsons and ACOG – the Area Council of Governments for central Oklahoma, used the **same LDC method** to prepare the TMDL for the North Canadian River and Cruthco Creek, which does directly impact Tinker.

4. We are opposed to the Canadian River TMDL for the same reasons stated in the comment letter from Robert M. Gill, Department of Defense Regional Environmental Coordinator, to John Craig, ODEQ. Attached for the record is a copy of that letter and certain enclosures.

5. We recommend that EPA and/or ODEQ at a minimum take the same actions as recommended in the comment letter.

6. The LDC method as used in Oklahoma is based on estimates. The Canadian River Report is likewise based on estimates. For example, deer populations within the study area were estimated from deer harvest information, and livestock numbers and livestock fecal coliform production were estimates. Even the bacterial contribution from a potentially significant source of bacterial loading to the watershed, failing septic systems, was based on an estimated eight percent failure rate. Further, the LDC method does not consider background bacteria, does not differentiate between human and animal bacteria, and does not identify specific sources or link them to actual levels of pathogens found in the Canadian River, Turkey Creek, the North Canadian River, or any other water body currently being studied for pathogen impairment. In short, it is not based on sound science at all.

7. There are methods available: to involve stakeholders in the study of pathogen loading; to obtain information from stakeholders, other state agencies, and interested individuals regarding watersheds, bacteria sources and control methods; to trace bacteria to their sources; to tell the difference between human and animal bacteria; to physically view watersheds and look for bacteria sources; and to develop management strategies that are actually designed to address identified sources of bacteria. The Canadian River TMDL does not use any of these methods, and is therefore not based on sound science or sound evidence.

8. Due to these very serious shortcomings of the LDC method, Tinker requests a moratorium on the development of all bacteria TMDLs in Oklahoma until a science-based, evidence-based method is used to develop TMDLs.

9. Process and Procedural Concerns. Tinker has substantive concerns regarding the process and procedures EPA is using in establishing TMDLs for the state of Oklahoma.

a. Documents and Reports not Publicly Available Prior to the Meeting. In conducting any public meeting under the Clean Water Act, EPA is subject to 40 CFR Part 25. Section 25.6 of Part 25 states:

> The requirements of § 25.5 (b) and (c) are applicable to public meetings, except that the agency holding the meeting may reduce the notice to not less than 30 days if there is good reason that longer notice cannot be provided.

Section 25.5 (b) states, among other things, that:

> Reports, documents and data relevant to the discussion at the public hearing [and public meetings under Section 25.6] shall be available to the public at least 30 days before the hearing [or meeting under Section 25.6].

Tinker is unaware of any documents related to the Canadian River TMDL that were made available to the public prior to 11 Aug 2006. On 11 Aug 2006, the Federal Register notice for this public meeting was published, and the Web site link listed in the Federal Register appeared on EPA's TMDL web site. This link is the first time Tinker is aware

prior to the meeting, EPA has not complied with 40 CFR sections 25.5 (b) and 25.6.

b. Lack of Adequate Notice. Tinker is concerned about the lack of public notice. EPA's Federal Register notice for the Canadian River TMDL is defective. It did not mention the meeting agenda, time, or location of the public meeting. It did not mention that a public meeting would take place at all. Further, there was no mention on EPA's TMDL web site for the Canadian River TMDL that any public meeting would take place. Tinker has had inadequate time to comment on the proposed TMDL or to prepare for this public meeting. Please note in this regard that 40 CFR § 25.5 (b), which applies to public meetings such as this (see 40 CFR § 25.6), requires notice to the public at least 45 days prior to the meeting. Forty-five days prior to the public meeting that took place on 23 Aug 2006 was 9 Jul 2006. Further, EPA has made no showing of any good reason why forty-five (45) days notice could not be provided. This forty-five day advance notice requirement is the same as that contained in Oklahoma's Continuing Process Planning (the CPP). Page 200 of that document requires that the state (or EPA in this case) provide public notice of the meeting agenda, time and location at least forty-five (45) days prior to the meeting. So, in addition to not complying with the forty-five day public notice requirements of 40 CFR § 25.6, EPA is not in compliance with Oklahoma's CPP.

c. Public Comment Period too Short. Tinker is concerned that the public comment period is too short. Oklahoma's CPP requires that formal written and oral comments be accepted for a period of thirty (30) days following the public meeting. Therefore, Tinker requests that EPA extend the deadline for comments to be submitted from the current deadline of September 11, 2006, to September 22, 2006. This extension is required to comply with Oklahoma's CPP.

d. EPA Interference in Oklahoma's Delegated Program. EPA has delegated the responsibility of issuing permits and enforcing the Clean Water Act and Oklahoma water quality standards to Oklahoma, specifically, the Oklahoma Department of Environmental Quality. This delegation includes studying and establishing TMDLs. Despite this delegation, EPA has taken over the process of establishing the Canadian River TMDL in place of the state of Oklahoma. The sole basis for EPA taking this action is to meet a deadline internal to EPA. This is not a legally sufficient basis for EPA to conduct the public participation or establish the Canadian River TMDL. The public is entitled to have Oklahoma decision makers, who answer to the residents of the state of Oklahoma, to make the decision to establish this TMDL, not EPA.

10. Conclusion. Tinker objects to this TMDL. It is not based on sound science or evidence. Tinker reserves the right to oppose any TMDL established using the load duration curve method when stakeholders have not been involved in the process, when no ground reconnaissance has been performed to identify sources, when estimates are used

in place of actual data, when sources of bacteria have not been actually identified and linked to the pathogen levels found in the water body, when background pathogen sources have not been considered, or when human bacteria have not been differentiated from animal bacteria or animal bacteria sources. Tinker requests that no TMDLs be established in Oklahoma until these requirements for a sound, science and evidence-based TMDL are met. Tinker further objects to EPA establishing this TMDL in place of ODEQ for the reasons stated. Tinker reserves the right to make additional comments within the comment period. Tinker also reserves the right to continue to object to any TMDL based in whole or in part on the load duration curve method.

CATHY R. SHEIRMAN
Chief, Environmental Management Division

Attachments
Letter from Robert Gill with enclosures
Comments from Susan Stell, AFCEE/CCR-D

Bacteria TMDLs for Canadian River, Oklahoma (OKWBID 52062), "EPA TMDL" for Upper Canadian River and Turkey Creek Watersheds of Oklahoma

Comments for August 23rd Public Meeting on the Proposed Upper Canadian River Watershed TMDLS

Submitted by Susan Stell, AFCEE/CCR-D, August 23, 2006

1. What is the WQ of the Canadian River upon entering Oklahoma? Is the river already exceeding OK WQS for pathogens and PBCR?

2. Waterbody designated use is inappropriate based on land use. Predominant land use is grassland/agriculture, so why isn't the designated use "agriculture" rather than primary or secondary body contact recreation? Furthermore, is body immersion in the tributaries, with the possibility of ingestion even possible during the swimming season?

3. Report notes that "only a small fraction of these fecal coliform (Tables 3-6, 3-7) are expected to represent loading into waterbodies." The watersheds are predominately agricultural, so what evidence is there to support this assertion?

4. All of the fecal coliform load from failing septic tanks is assumed to reach the waterbodies (Table 3-9). This is not a reasonable assumption, particularly in light of the assumptions made about farm livestock providing only a small fraction of the load to the waterbodies. Much of the fecal coliform from failing septic tanks will be trapped underground and not exposed to runoff.

5. Loading from Domestic Pets: Urban/suburban rates of pet ownership are only a gross estimate of pets in agricultural areas, which tend to have more cats and dogs that are loose.

6. All of the fecal coliform load from cats and dogs is assumed to reach the waterbodies (Table 3-13). This is not a reasonable assumption, particularly in light of the assumptions made about farm livestock providing only a small fraction of the load to the waterbodies.

7. Table 3-13 has too many assumptions built into it to be even remotely accurate. It also does not identify the load coming from Texas or the purely background load.

8. There are no valid stream gage stations in the watershed to base the watersheds' flow duration curves upon. This is a fatal deficiency in this TMDL report, rendering subsequent calculated loads and needed decreases meaningless. Real flow data is needed to calculate pathogen loads. Also, extremely low flow conditions typical of small intermittent streams are noted in section 4.2 and under several of the flow duration curves. If the flow is that low and the streams only flow sometimes (especially during the summer), then how can a PBCR use be assigned to many of the tributaries? The designated use is inappropriate for these tributaries.

9. Flow data is only available just downstream of the study area (USGS gage station 07228500). What does this flow duration curve look like? It should be in the report as a reference. Are there any pathogen data taken over the years at this site? If yes, were pathogen load duration curves made and compared to the data generated for the study area to determine if they were similar?

10. With no stream gage data available in the watersheds, actual sources (BST) of pathogens undetermined, and gross estimates of pathogen loading made using literature sources and some unwarranted assumptions, the waterbodies should have never been classified as Category 5 impaired waterbodies. They should have been classified as not enough information available to classify.