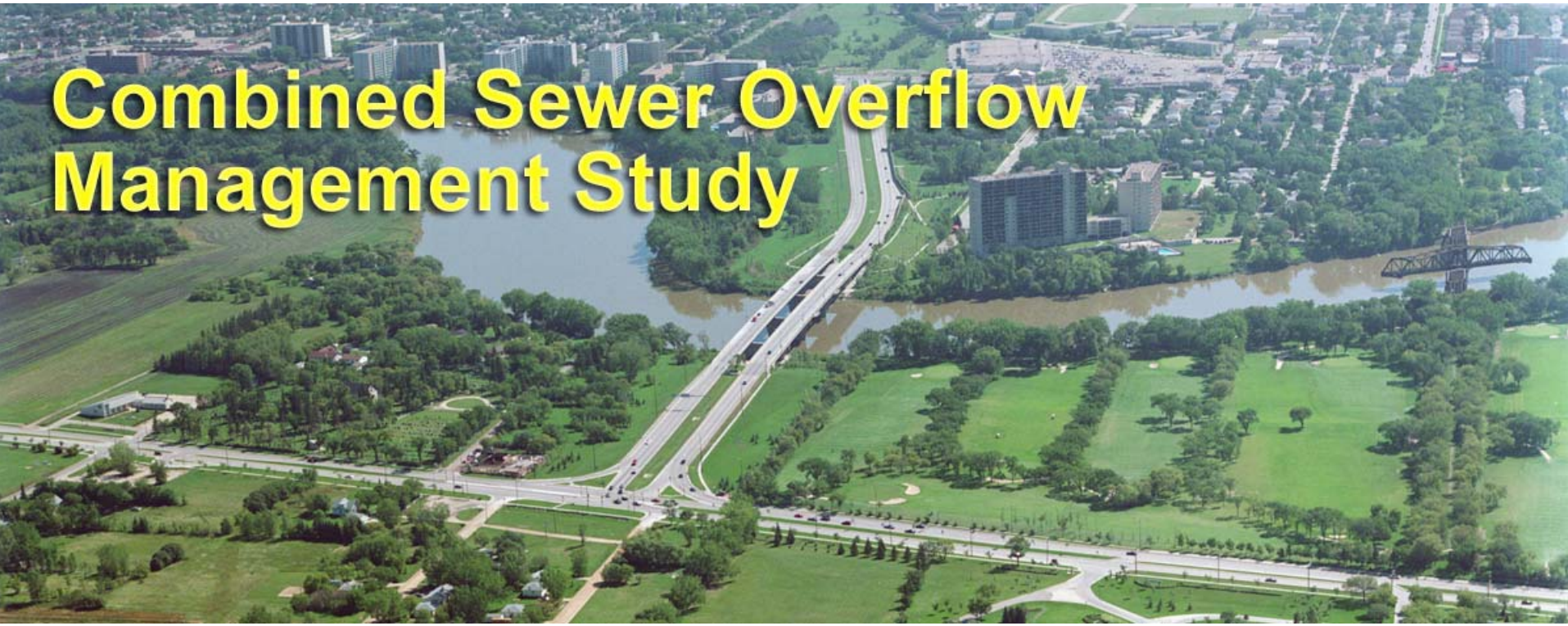


Winnipeg CSO Study

Outline

- Background to CSO study
- The CSO Problem
- The Winnipeg CSO Study
  - Scope
  - Public Consultation
  - Advisory Committee
  - Technical Approach
- Control Options
- Illustrative Control Program
- City's Proposed Program


Background to the CSO Study

Background to the CSO Study

- At the request of the Minister of Environment, the Clean Environment Commission (CEC) held public hearings on the classification of the Red and Assiniboine Rivers in the Winnipeg area (1991/92).
- CEC Recommendations accepted by Minister of Environment (November 1993)

CEC Recommendation 7

Order required site-specific studies to determine water quality impacts of the combined sewers(CS) on the rivers. Studies should include, but not be limited to, the following:

Study Requirements	Status
▪ Physical inventory of combined sewers and affected river reaches	☑
▪ Monitor flow events to understand impacts of CSOs on river quality, particularly at low flows	☑
▪ Develop understanding of routing through sewer system during dry and wet weather	☑
▪ Monitor flows in sewers and rivers	☑
▪ Set up rainfall monitoring network	☑
▪ Monitor water quality during overflow events of CSOs on river quality, particularly at low flows	☑
▪ Establish parameters concerning storm frequency and duration that fecal coliform levels must be met	☑

CSO Consulting Team

Project Manager - G. Rempel, P.Eng., TetrES
Consulting Firms:
Wardrop Engineering Inc.
TetrES Consultants Inc.
CH2MHill (Canada)
EMA Services - Instrumentation & controls

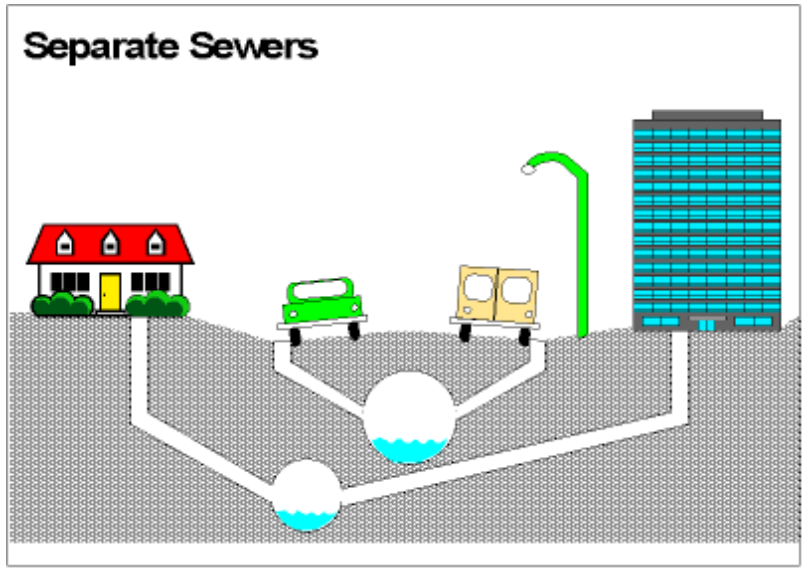
Specialists

C. Rowney, Ph.D., P.E. (CDM) - **Modelling**
P. Moffa, P.E. - **CSO Engineering**
D. Weatherbe, P. Eng. - **Experience Elsewhere, Regulatory**
N. Wheatly - **USA Regulatory**
W. Schilling, Ph.D., P.E. - **Real Time Control**
G. Zukovs, P. Eng. - Control Options


The CSO Problem

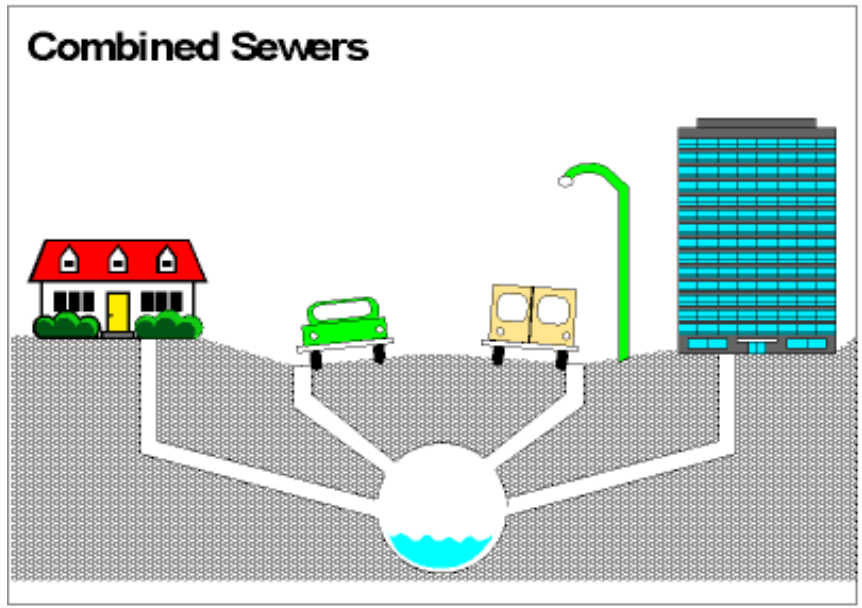
Separate Sewer System

- New areas
- Two-pipe system, one for wastewater and one for stormwater
- All wastewater taken to treatment plant (except for extreme wet weather conditions)
- Does not eliminate debris from land/street runoff



Combined Sewer System

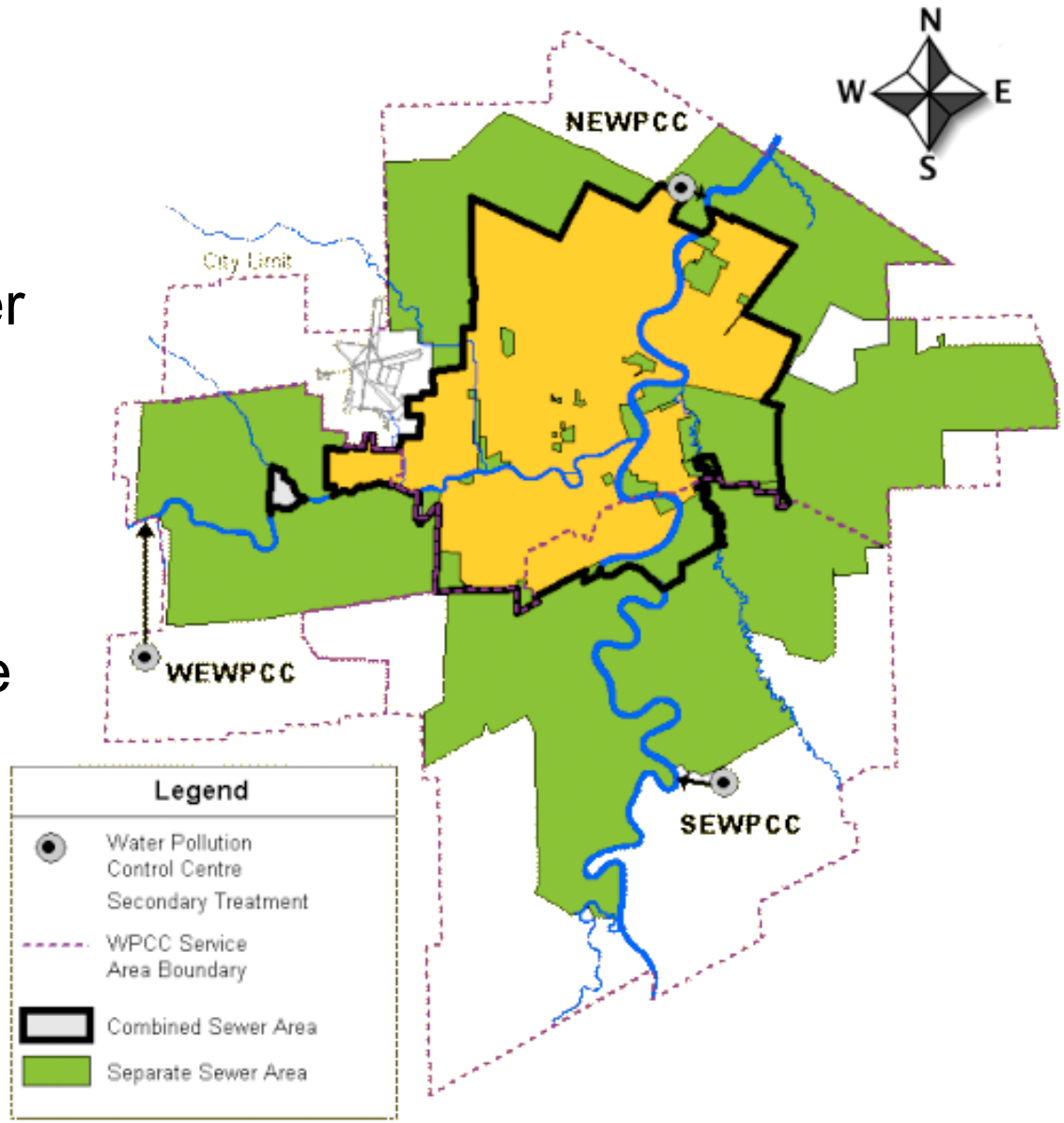
- Older areas
- Single-pipe carries both wastewater and stormwater
- **During dry weather**, all flow goes to treatment plant;
- **During wet-weather**, combined wastewater (dilute mixture of sewage and stormwater) overflows to rivers;



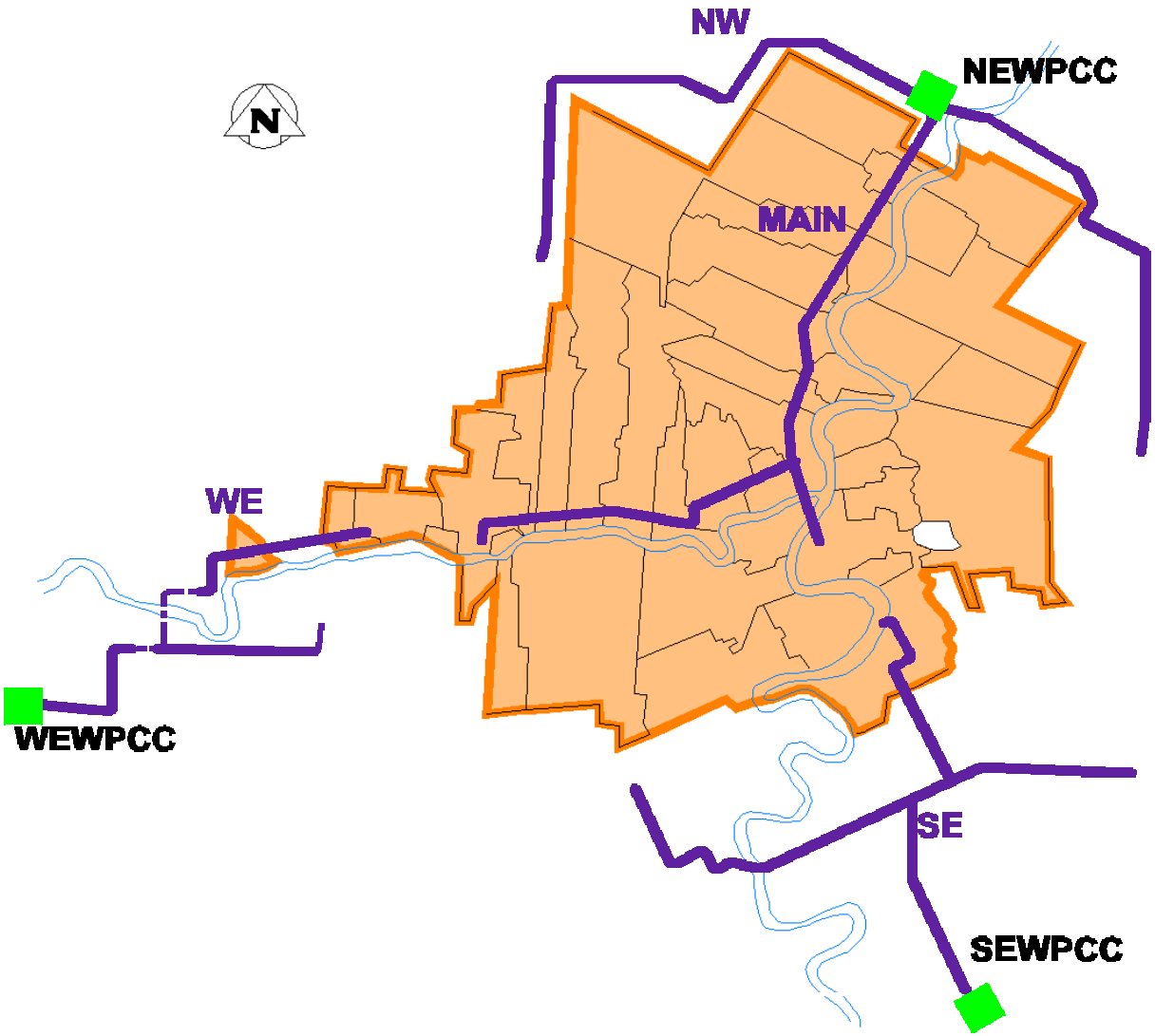
Combined Sewers Exist Worldwide

- Many European cities have combined sewers
  - control strategies being developed
- In North America, about 850 communities have combined sewers
  - e.g., Boston, Chicago, San Francisco
- In Canada, cities include Halifax, Quebec City, Montreal, Toronto, Edmonton, Vancouver
- In Manitoba, portions of Winnipeg, Brandon and Selkirk sewer systems have combined sewers.

- Existing Systems
  - 5 Interceptor Sewer Sysems
  - 3 Pollution Control Centres
  - 79 CSO Locations
  - 231 Land Drainage Outlets
    - 101 to Red and Assiniboine
  - 2 major rivers



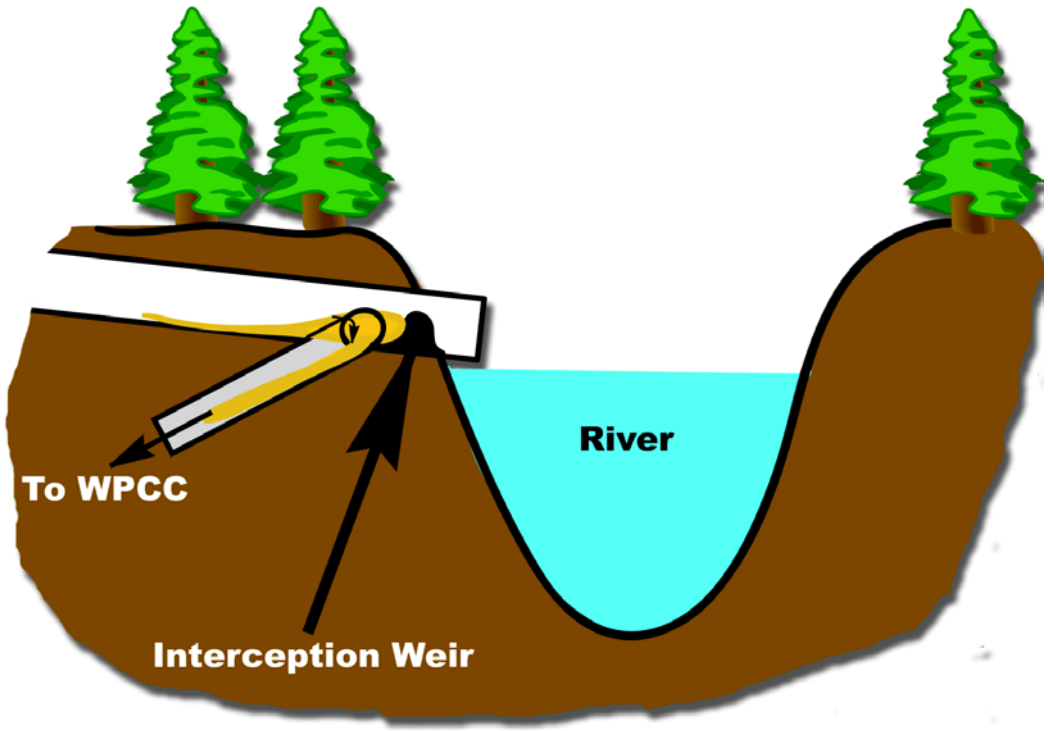
WINNIPEG'S COMBINED SEWER SYSTEM



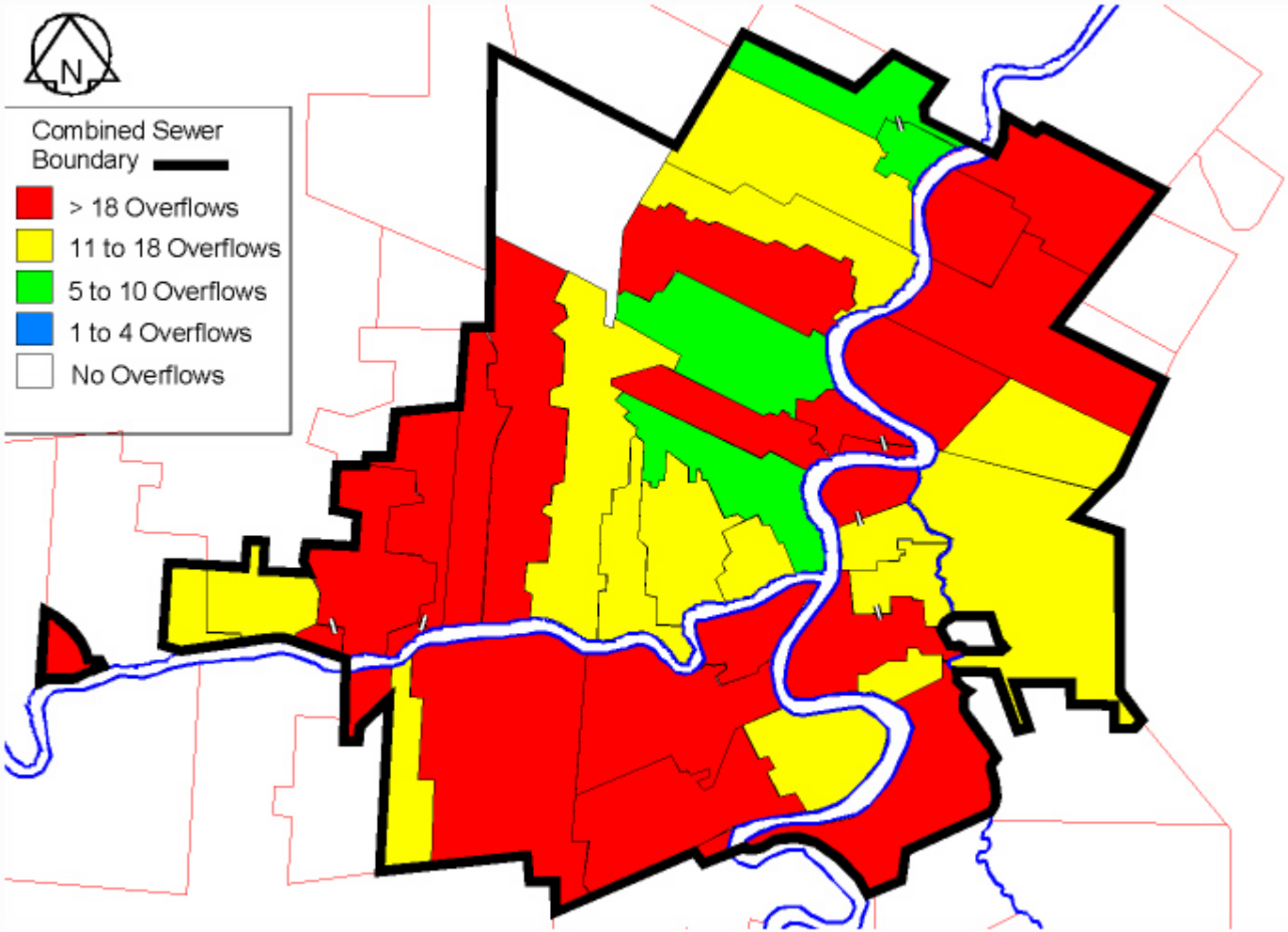
- About 8,700 ha
- 43 districts, about 76 outfalls
- Many districts have had additional trunk sewers installed for basement flood relief, resulting in additional outfalls

Winnipeg's Combined Sewer System

- During dry weather, all sewage is intercepted and transported to treatment
- During most rainfalls, overflows occur
- Overflows occur about 18 times/year on average
- About 1% of the total annual sewage generated is lost to overflows



Long-Term - Existing Interception Rate

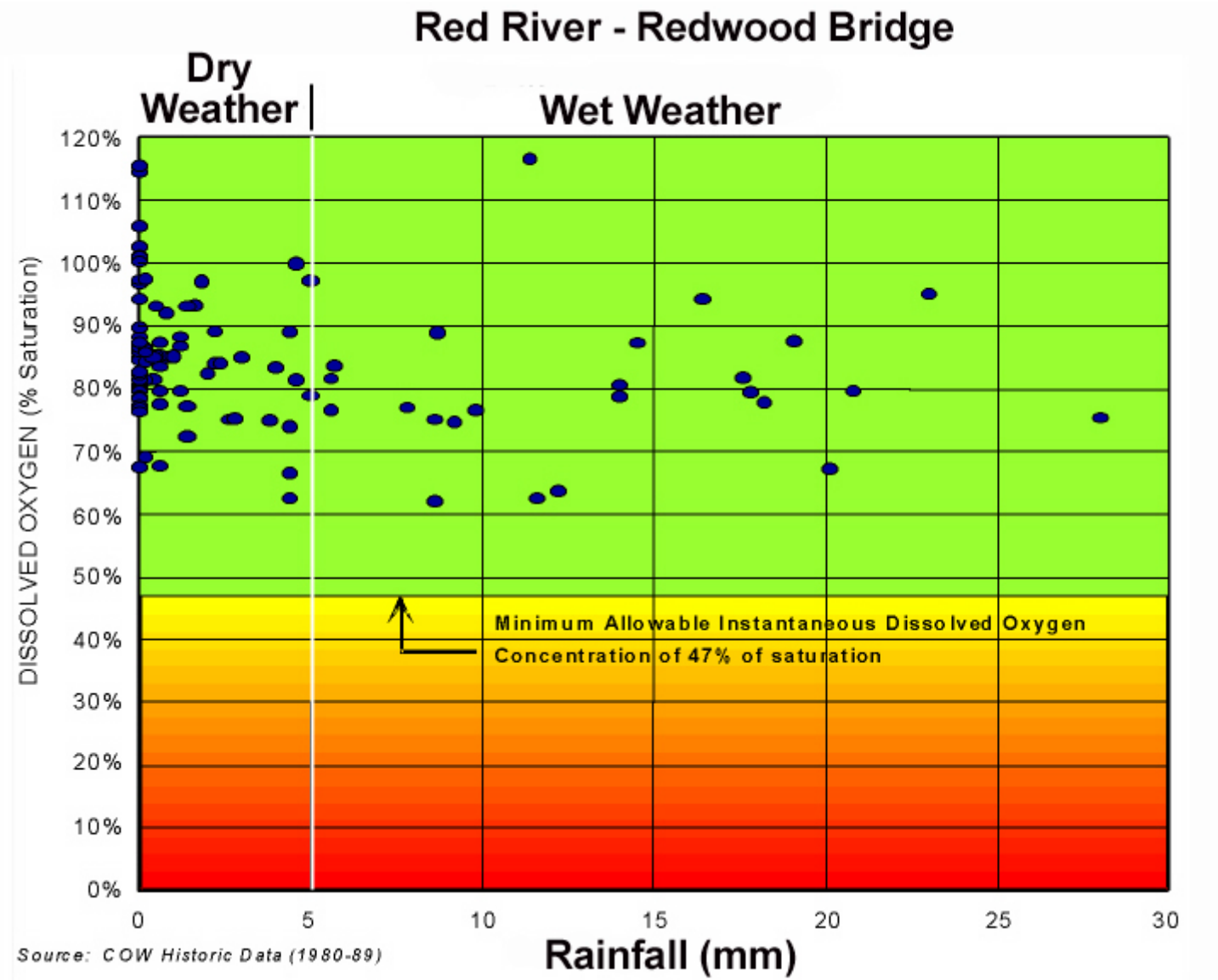


Average Annual Overflows ~ 17.5
Range: 6.5 - 30

Effects of CSOs in Winnipeg

- Do not significantly affect ammonia levels in the rivers
- Do not cause significant Dissolved Oxygen depression
- Do cause non-compliance with provincial microbiological objectives
- Do affect aesthetic quality of rivers (floatables)

Dissolved Oxygen Remains High

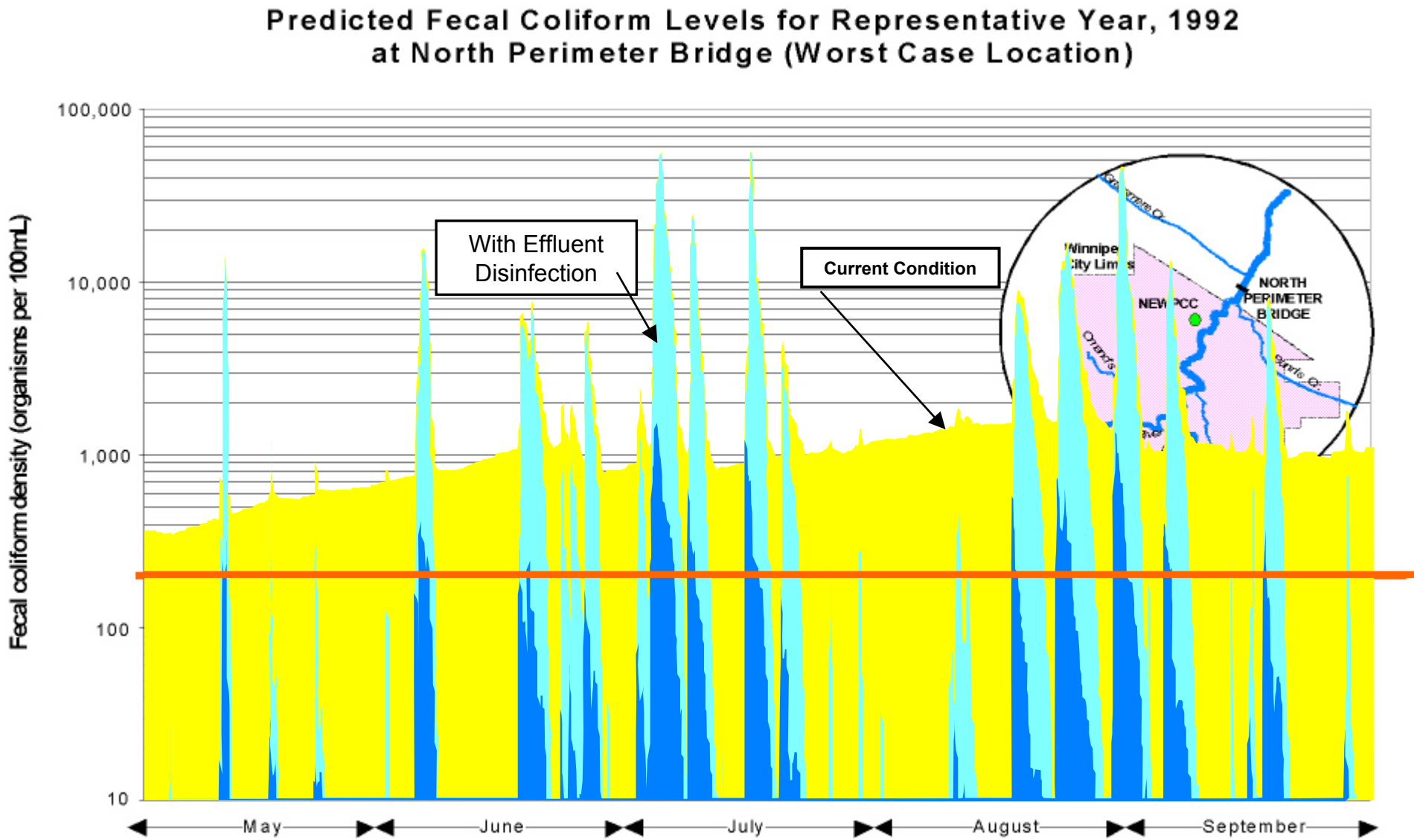


Microbiological Water Quality

- Fecal Coliform (FC) bacteria typically are used as an indicator of contamination
  - FC are not pathogenic (disease-causing) but indicate contamination from the intestine of a warm-blooded animal
  - a level of 200 FC organisms/100 mL or less is typically used as a measure of acceptable water quality for beaches, irrigation of produce

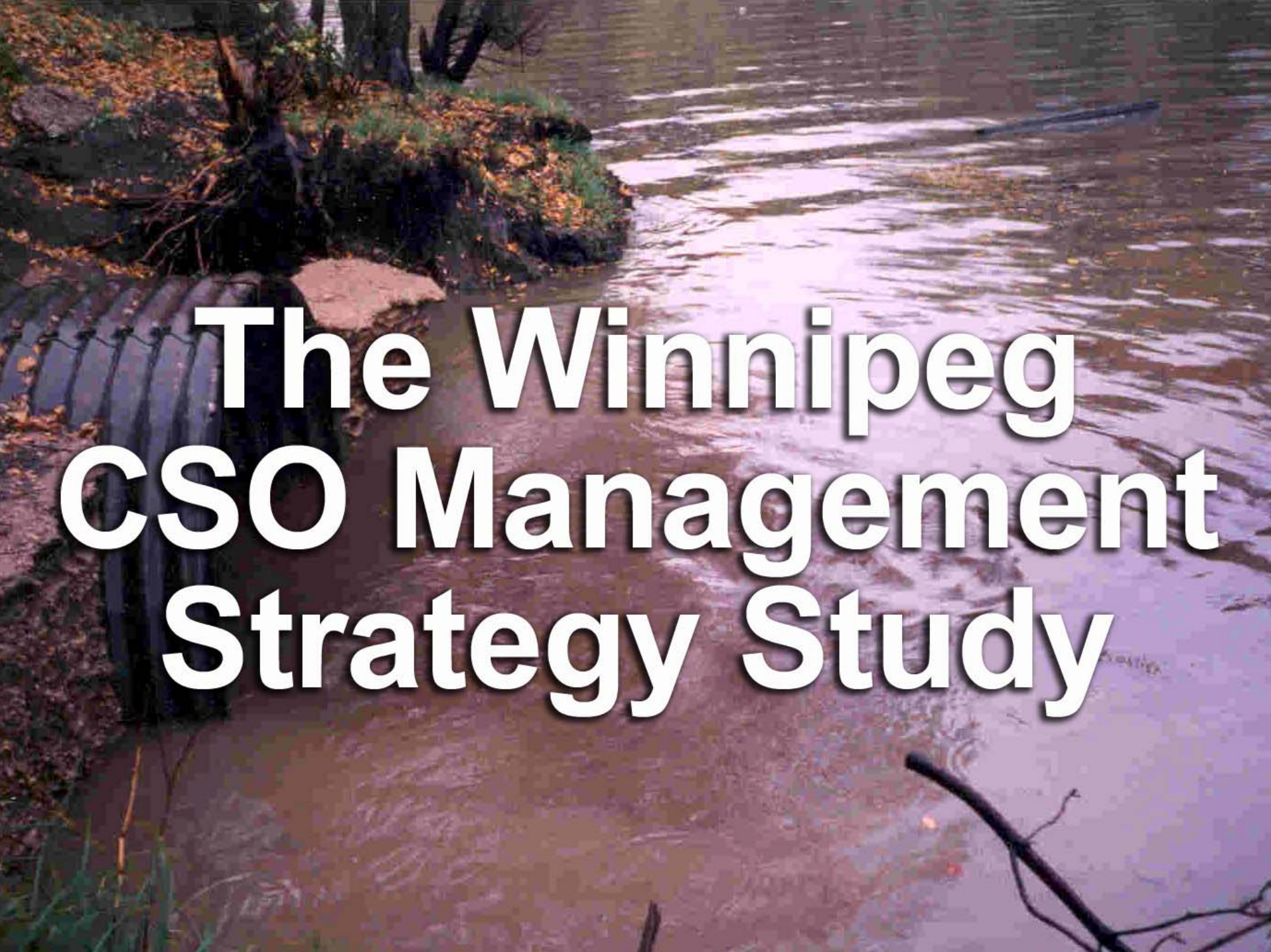
Representative Fecal Coliform Concentrations

SOURCE	ORGANISMS / 100 mL	
	Before Disinfection	After Disinfection
Dry Weather		
WPCCs	200,000	200
Wet Weather		
LAND DRAINAGE		
Ponds	20,000	20,000
Direct Discharge	40,000	40,000
CSO	2,400,000	2,400,000


Predicted Fecal Coliform Levels for Representative Year, 1992
at North Perimeter Bridge (Worst Case Location)
Fecal coliform density (organisms per 100mL)
100,000
10,000
1,000
100
10
With Effluent Disinfection
Current Condition
NORTH PERIMETER BRIDGE
May
June
July
August
September

Major CSO Water Quality Issues

- Microbiological Contamination
  - periodic excursions of provincial objectives for recreational use of the rivers, produce irrigation
- Environmental Policy
  - discharge of diluted raw sewage
- Aesthetics

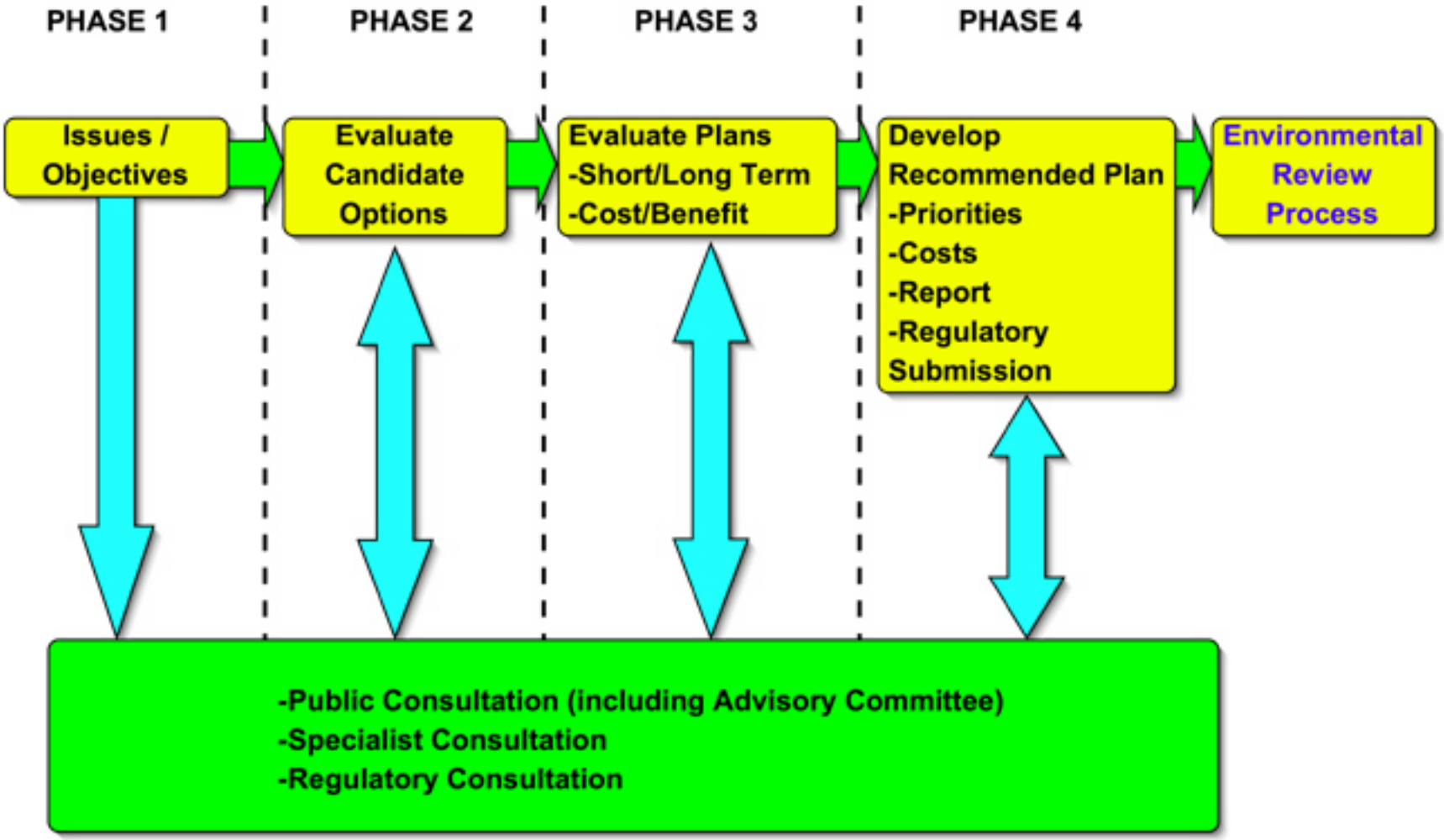


The Winnipeg CSO Management Strategy Study

Study Objectives

- Develop understanding of effects of CSOs on river quality and river use
- Develop comparative cost and benefit information for practicable CSO control alternatives
- Provide relevant information to enable informed value-judgements by policy-makers and public
- Assist in defining a cost-effective prioritized implementation plan for remedial work

Phased Approach



Public Consultation

- General Public
  - Open House (3 -1994; Winnipeg / Selkirk 2003)
  - Mall Displays (4 – 1995)
  - Family Fish Festival (2 – 1995 / 1996)
  - Rivers & Creeks Workshop (1 - 1995)
  - Mid-Canada Boat Shows (2 – 1996 / 1997)
  - Home Expressions (5 – 1996 through 2000)
  - Trade Show (1 - 1997)
  - Western Canada Water & Waste Assoc. (1 – 1997)
  - Public Works Day (2 – 1999, 2000)
- Approximately 40 days total of consultations

Public Consultation

- **Special Interest Groups**
  - Urban Planning Committee
  - Rotary Club
  - River Users Group
  - The International Coalition Conference
  - Red River Basin Commission Meetings and Conference

PUBLIC CONSULTATION

- Reports for Public Use
  - Phase 1 Report
  - Phase 2 Report
  - Study Updates
- Media Coverage
  - Newspaper articles
  - City of Winnipeg Web site link
- Scientific Community
  - Local Scientists
  - Technical Presentations

ADVISORY COMMITTEE

- Chris Leach, Manitoba Housing - Chair
- Dr. Sande Harlos, Winnipeg Regional Health Authority
- Dr. Jim Popplow, MOH, Environment
- Dr. Margaret Fast, Medical Health Officer, WRHA
- Randy Borsa, City of Selkirk
- Charles Conyette, Manitoba Conservation
- Art Derksen, Natural Resources
- Darwin Donachuk, Natural Resources
- Garry Swanson, Natural Resources
- Cheryl Heming, Parks & Recreation Winnipeg
- Drew Bodaly, Fisheries & Oceans

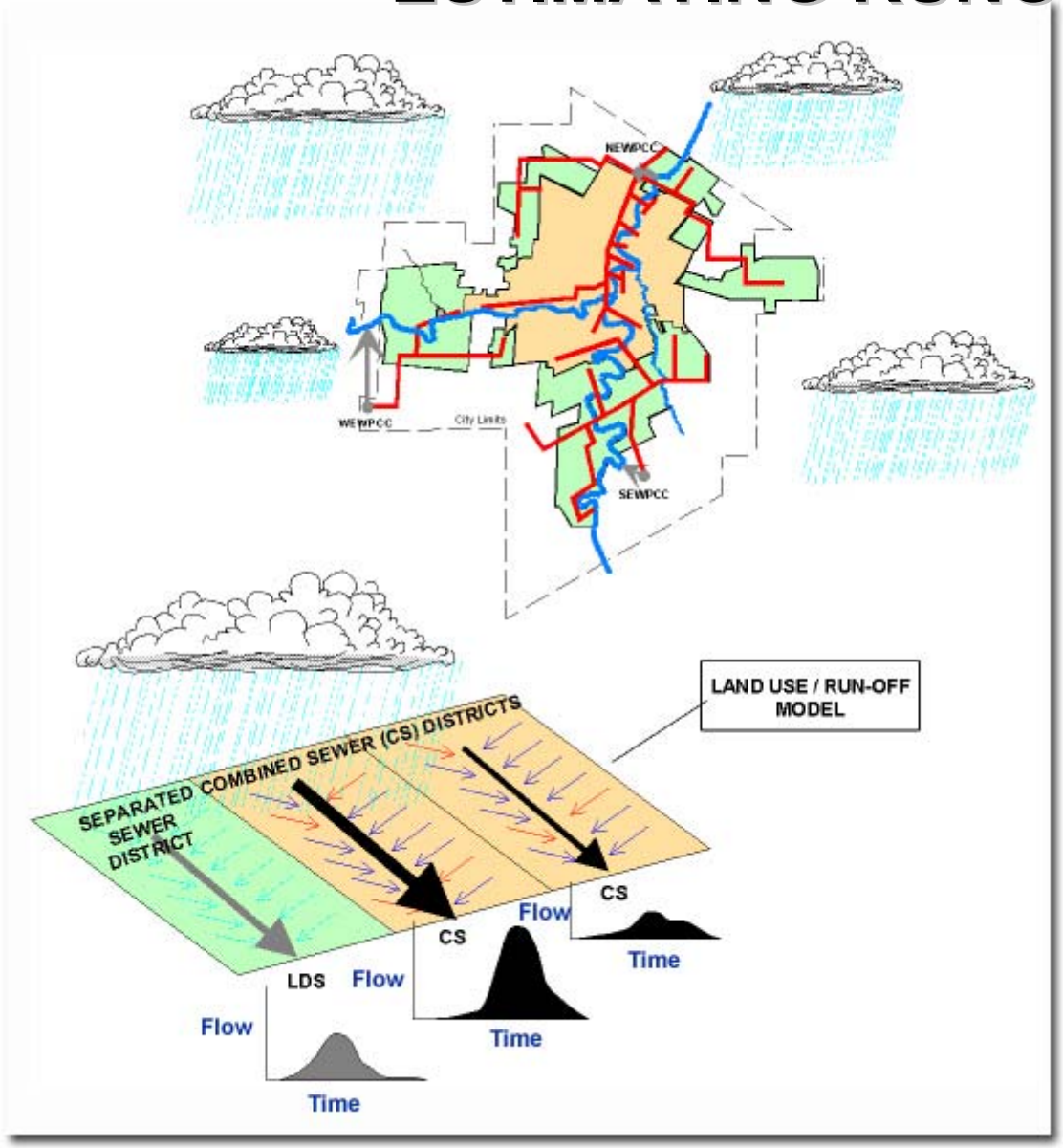
ADVISORY COMMITTEE ACTIVITIES

- Met 17 times
- Reviewed information, provided guidance, reviewed reports
- Active participation Illness Risk Report (Appendix 1 of Final Report)
- Provided letter of final comment (copy provided to CEC)

TECHNICAL APPROACH

- Study has defined a very wide range of potential CSO control plans and estimated the associated performance and costs

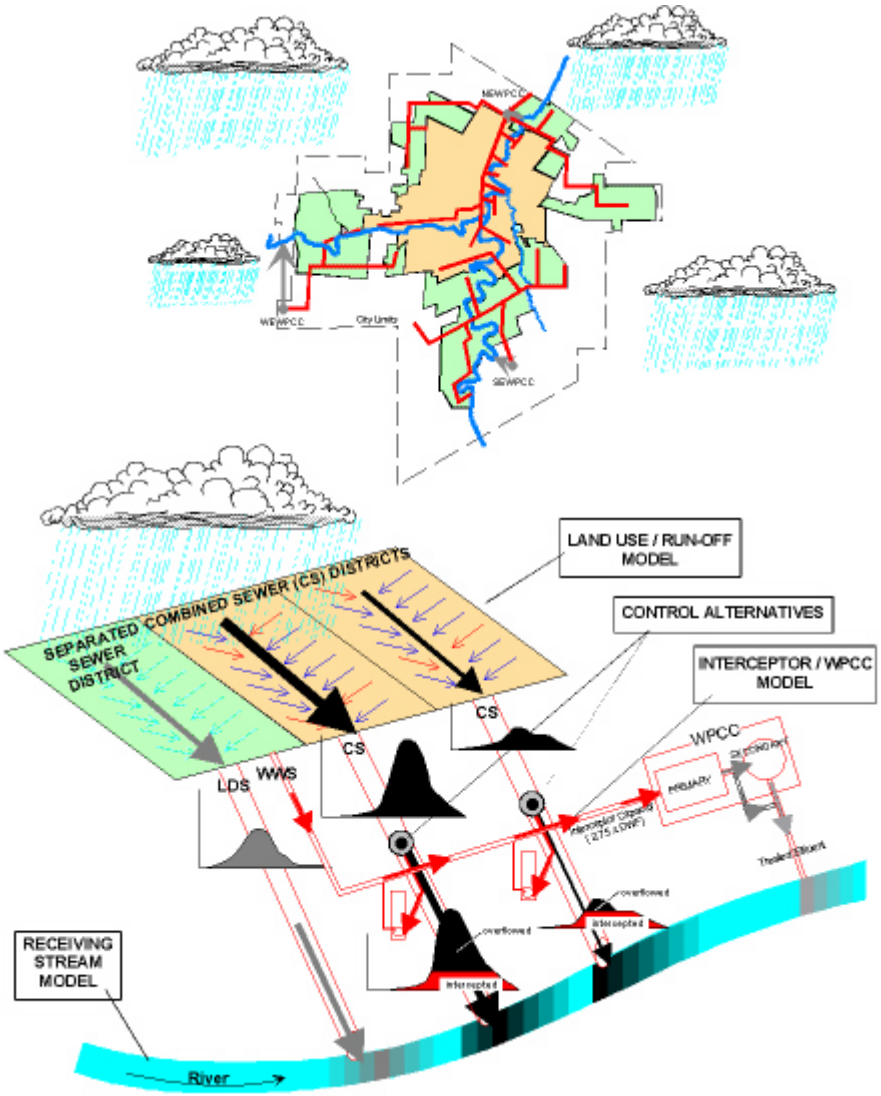
ESTIMATING RUNOFF



Runoff

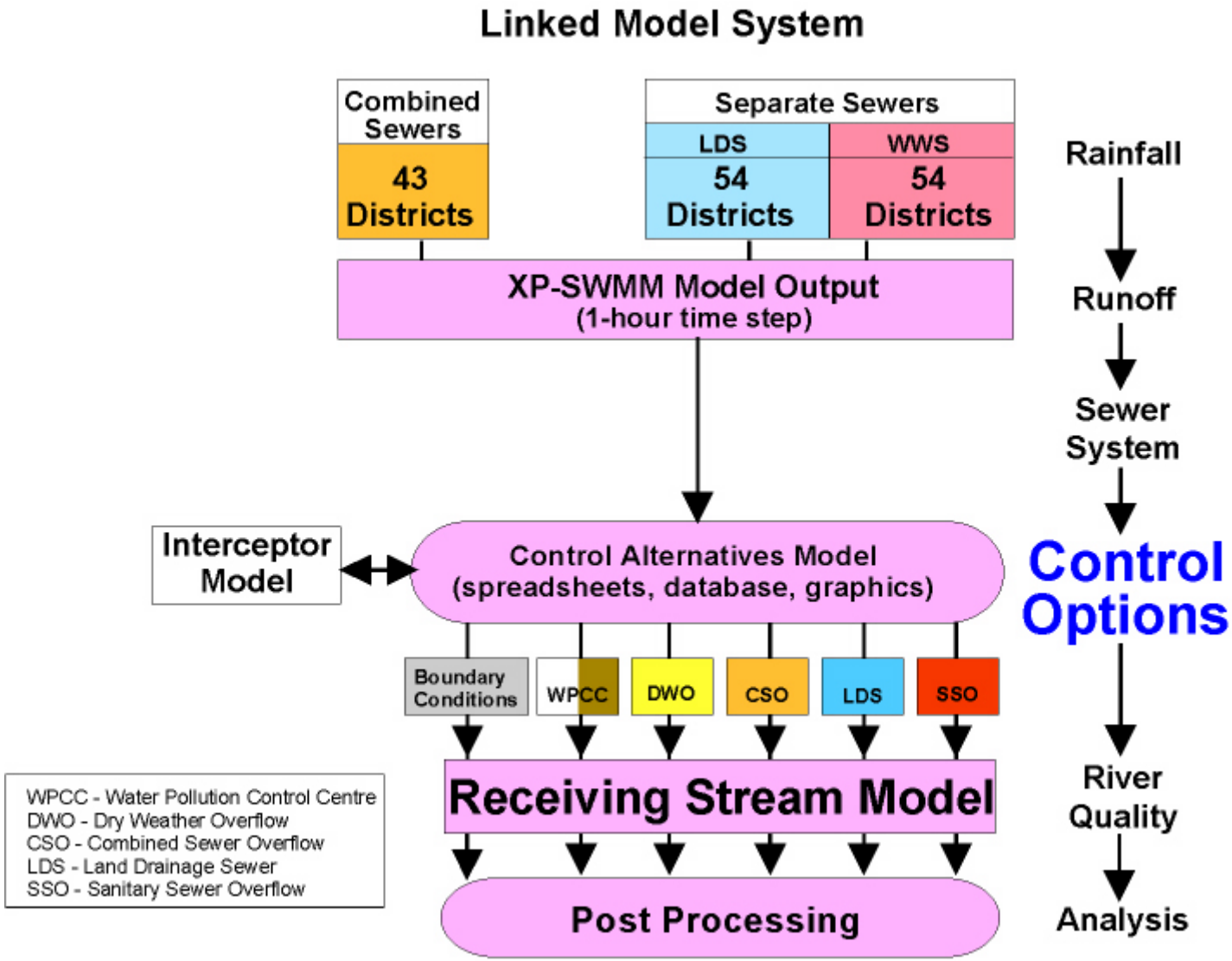
- **Required Extensive Monitoring**
  - Rainfall
  - Flow
  - Quality
- 30 yr. record of rainfall

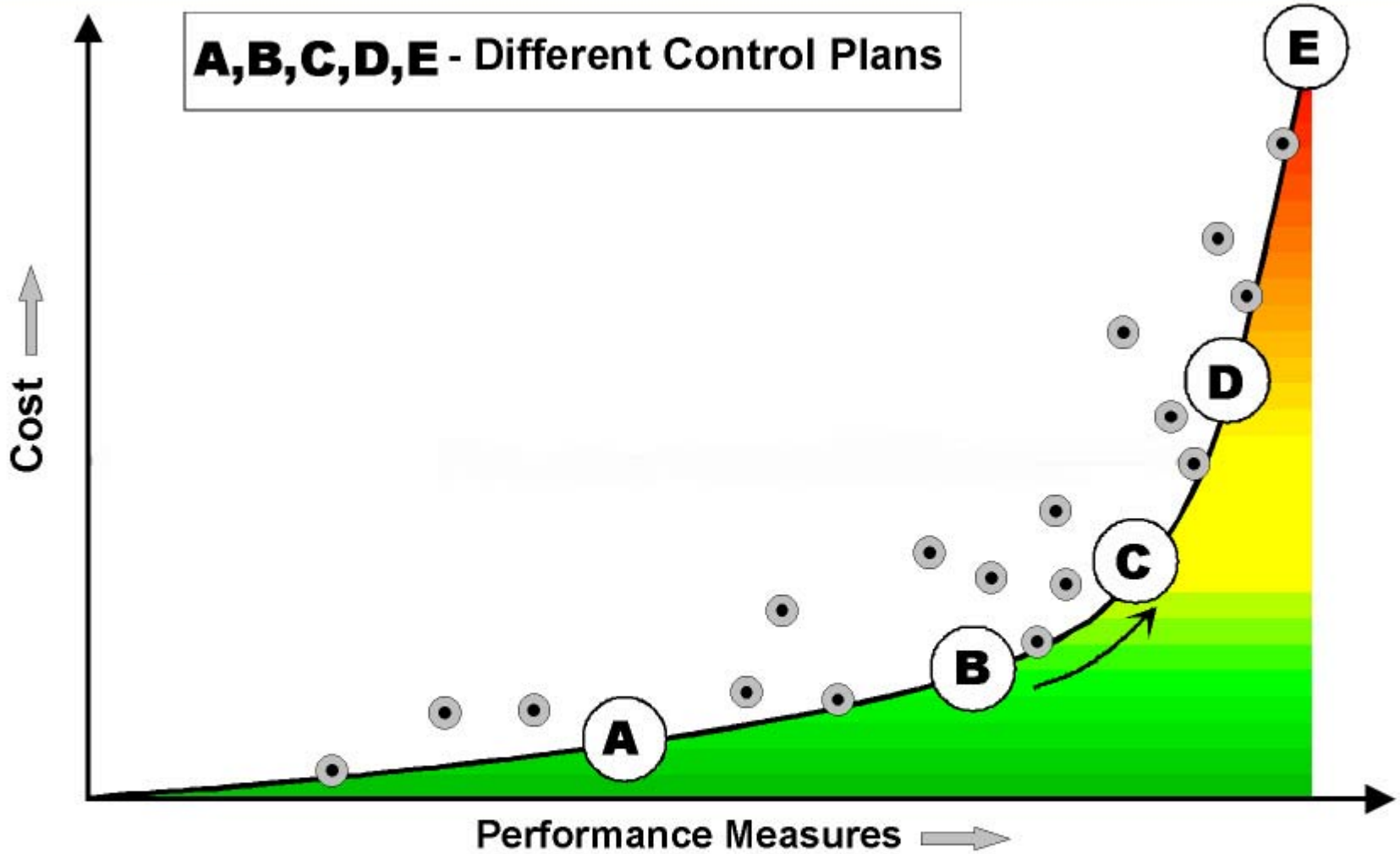
ESTIMATING CSOs



- Rainfall was routed through system for 30 year period of rainfall
- Effects on river quality estimated for each event

CONTROL ALTERNATIVES





Example Measures

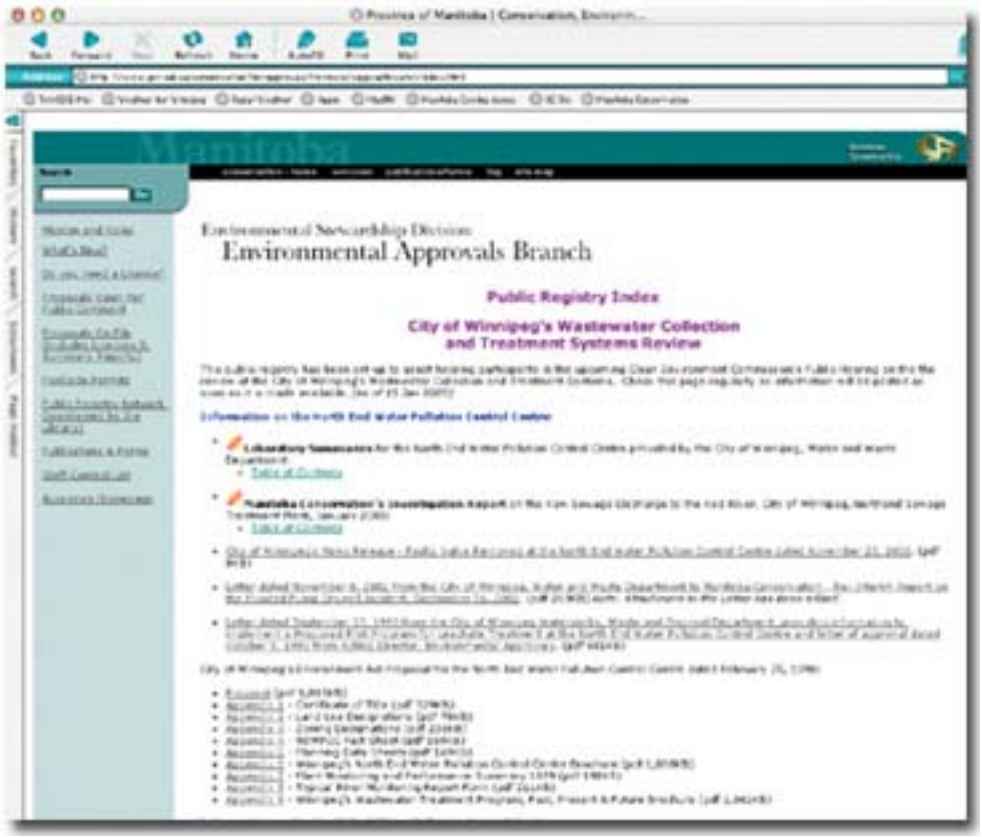
- higher compliance with objectives
- lower number of overflows
- lower volume of overflows

TECHNICAL PEER REVIEW

- **CSO Specialty Conferences**
  - Urban Effects on Water Quality in the Red River and Related Uses, Quebec City 1996
  - Application of Linked Models to Develop CSO Control Plans, Quebec City 1996 and Dallas,TX 1996
  - In-Line Storage With and Without Real Time Control, Cleveland 1998
  - Winnipeg's Floatable Capture and Quantification Program, Cleveland 1998
  - Urban Wet Weather Case Study, Cleveland 1998
- **Other Technical Conferences**
  - The City of Winnipeg's Combined Sewer Management Study and the Partnering Process, Toronto 1996 and Saskatoon 1996
  - Preparation for Informed Decision-Making, Winnipeg 1997
  - Effluent Impact Modelling Workshop, Winnipeg 2001

Study Documentation

- **Phase 1**
  - 9 Technical Memoranda
  - Phase 1 (“Reader Friendly”) Report
- **Phase 2**
  - 7 Technical Memoranda (Including 3 Appendices)
  - Phase 2 (“Reader Friendly”) Report
- **Phase 3**
  - 3 Technical Memoranda (Including 9 Appendices)
- **Phase 4**
  - Final Report and Executive Summary
  - 1 Appendix – “Illness Risk Report”
- **All documents provided to Regulator and CEC**
  - **Available to public via download and public registries**



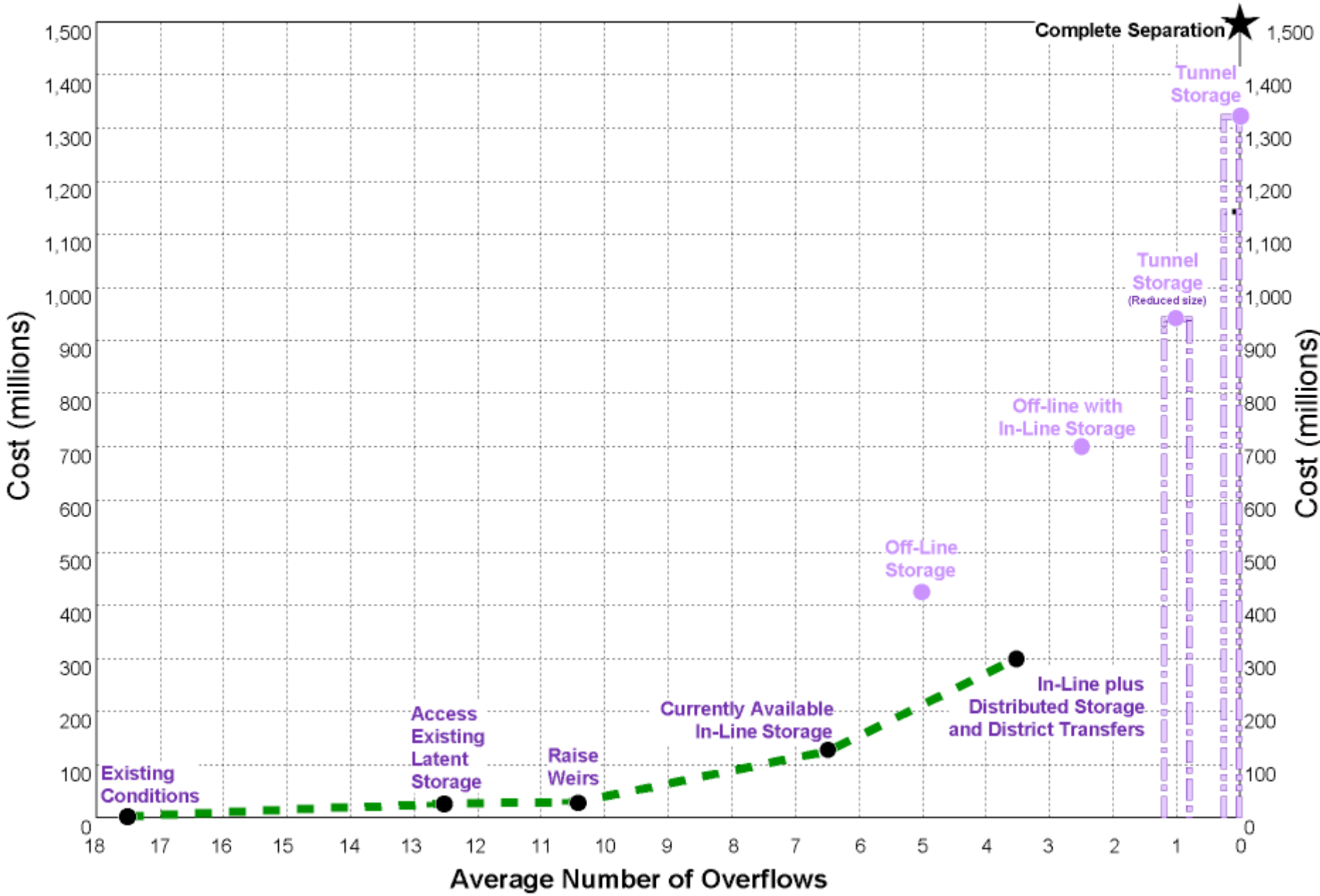
CSO Control Options

COMPARATIVE EVALUATION

Control Options were evaluated against performance measures, including:

- **Compliance with water-quality objectives (MSWQO)**
- **Numbers of overflows**
  - measure of aesthetic control
- **Volume of overflow captured**
  - measure of pollutant capture

Wide Range of Costs for CSO Control

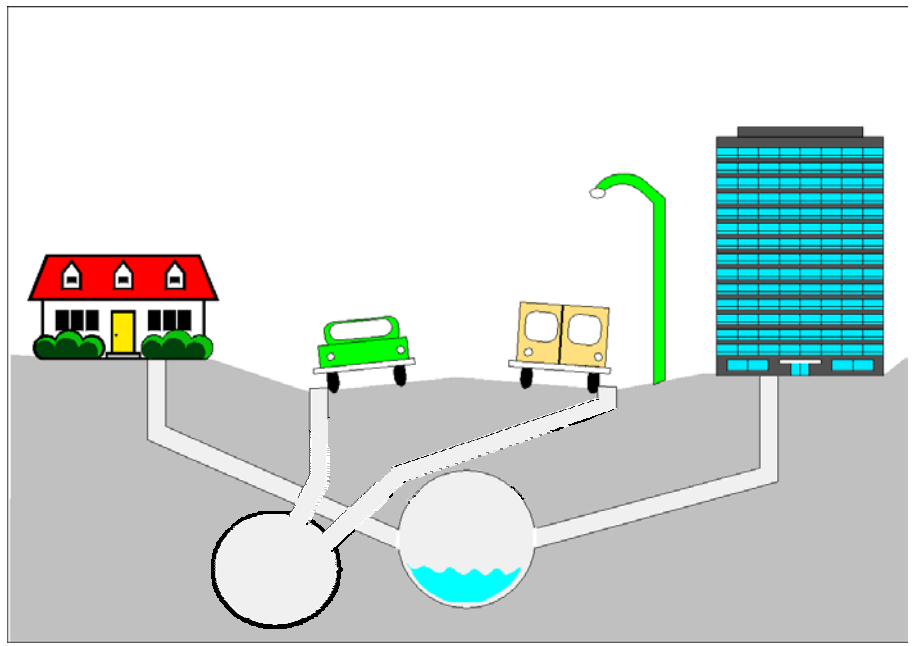


CONTROL METHODS

- **Separation**
  - Reconfiguration of existing pipe system to a separate sewage/land drainage system
- **Storage of wet weather flow (dewatering after rainfall)**
  - In pipes (in-line storage)
  - In tanks or tunnels (off-line)
- **Treatment of Overflows**
  - Central treatment
  - “End of pipe” treatment

SEPARATION

- Requires installation of new separate storm sewers.
- Connection of existing catchbasins to new sewers.
- Disconnect existing catchbasin from combined sewer system.
- Surface restoration.



CONSTRUCTION IMPACTS

- New sewers generally installed by “trenchless” methods (via access shafts)
- During construction there is disruption to:
  - local and through traffic;
  - bus routes; and
  - pedestrians and the community at large.
  - businesses

TYPICAL CONSTRUCTION SITE

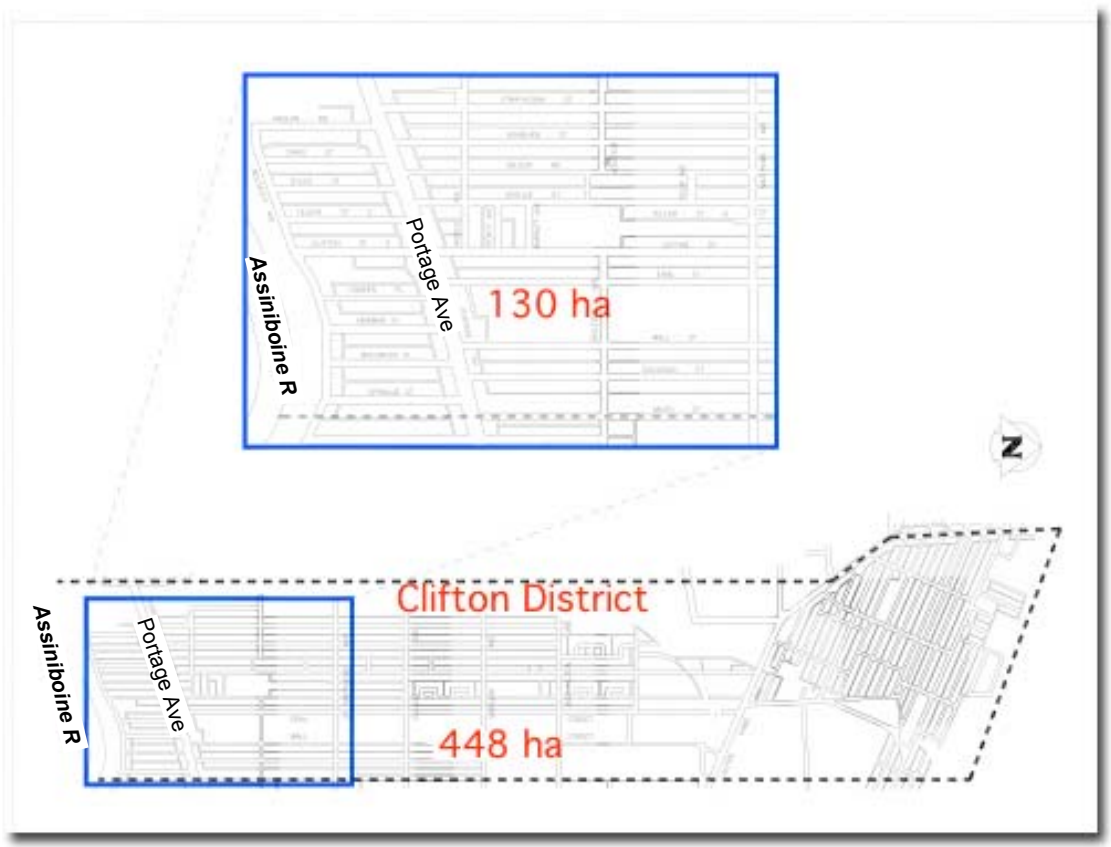
Marion / Despins

CS district

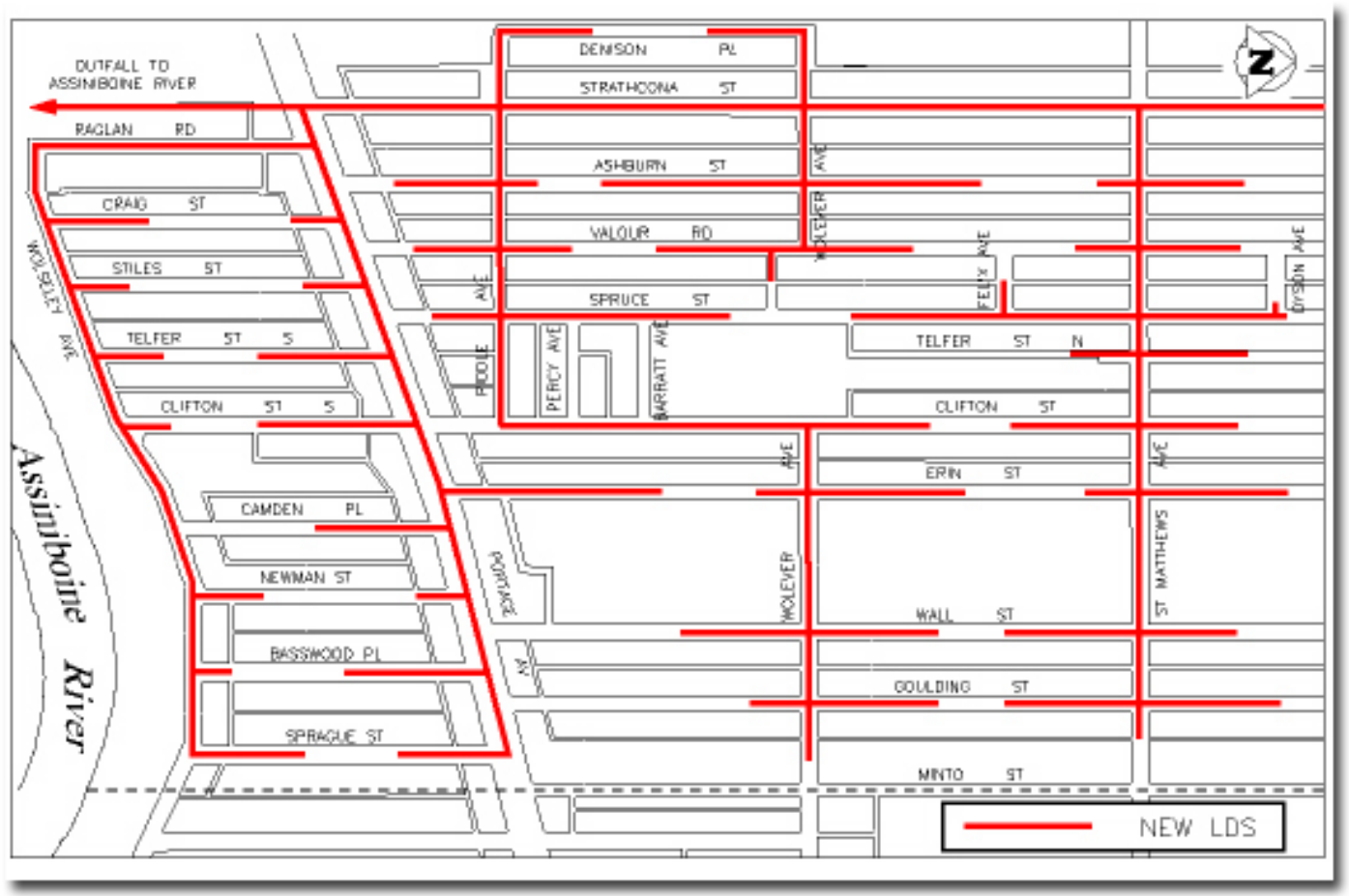
EXTENT OF CONSTRUCTION

- Portion of Clifton Combined Sewer (CS) District used to illustrate area affected by separation.
  - Portion covered 130 hectares (ha.) of the 448 ha. Clifton District with approximately 12,700 metres of CS.
- Conceptual design of separate system requires 8,600 m of new mainline piping.
- Construction required on **approximately 80% of existing streets.**

CLIFTON DISTRICT AND TEST SECTION



CONCEPTUAL SEPARATE SEWER ROUTING



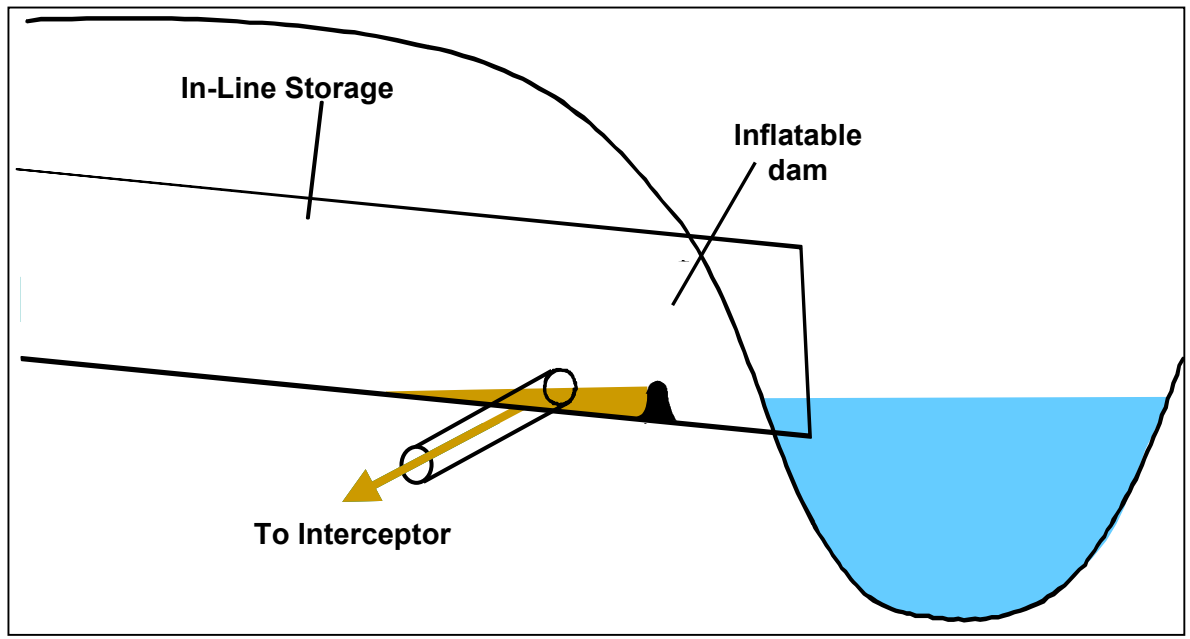
SEPARATION IS VERY COSTLY

- Estimated at about $1.5 **Billion**
- Very disruptive to community

IN-LINE STORAGE

- **In-Line storage involves retaining wet-weather flow in the pipe for smaller rainstorms**
  - After the rainstorm, the stored wastewater is pumped to the WPCC
  - If the rainstorm threatens basement flooding, all flow is released to river (no added risk to basement flooding)

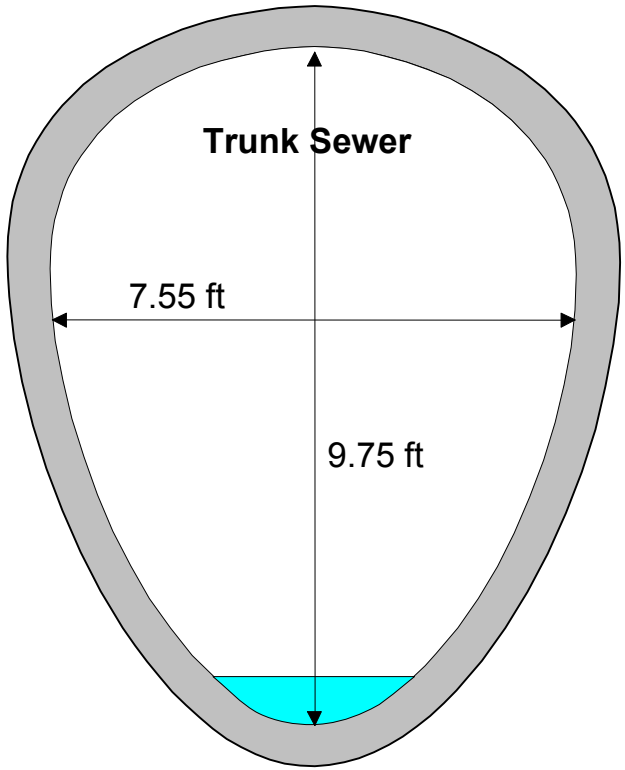
- **Needs Local Testing**
  - Sediment deposition
  - Odours
  - Minimize risk of basement flooding (reliability/liability)



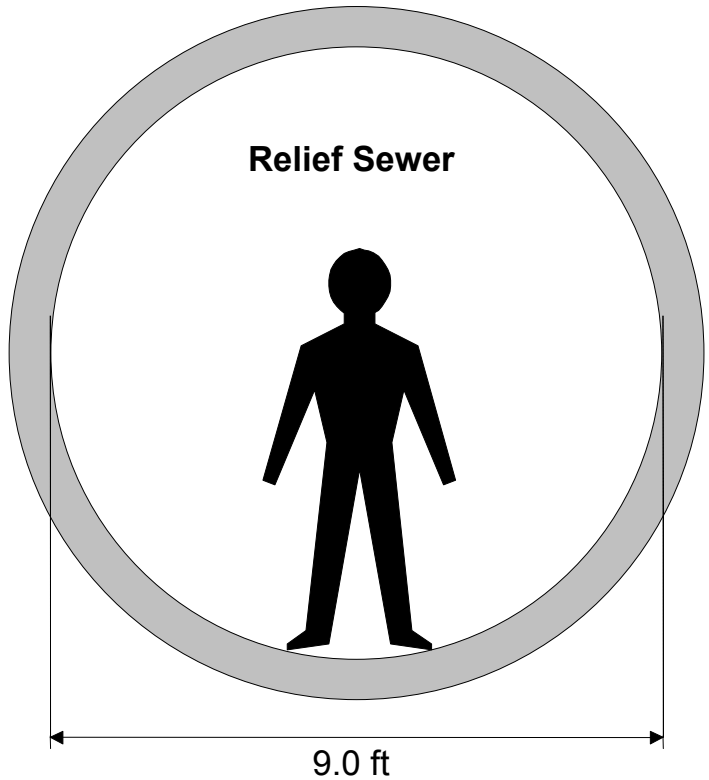
- **This strategy is, and has been, used successfully in other jurisdictions (eg. Cleveland and Detroit)**

IN-LINE STORAGE

Large old trunk sewers offer potential storage for combined sewage during smaller storms



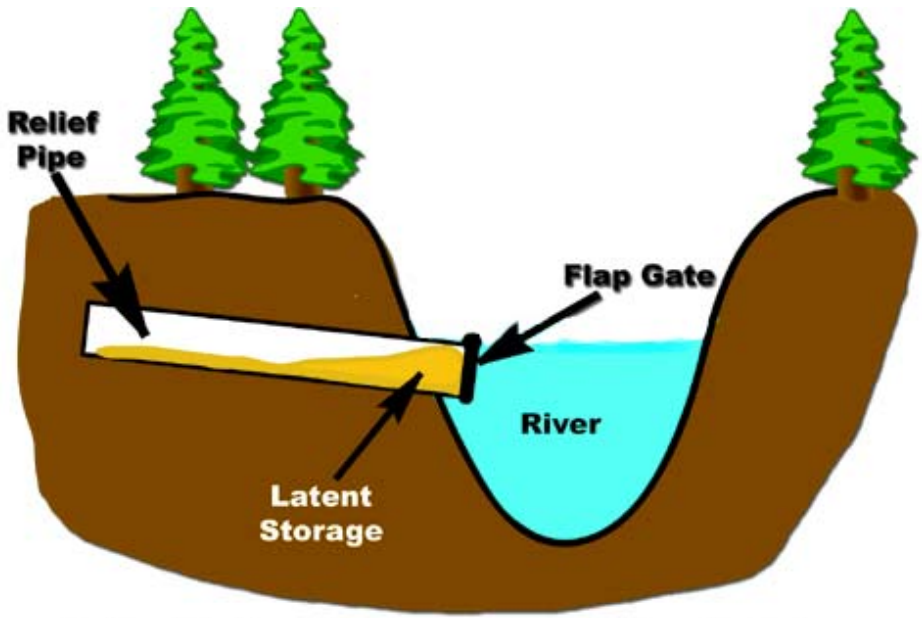
Relief sewers constructed for basement flooding also provide large volumes of potential storage



- **In-line storage reduces cost of CSO control by $200M**

EXISTING RELIEF SEWERS OFFER LATENT STORAGE

- Available in portion of relief sewers which are below river level
- If these pipes are dewatered the storage could be available for inline storage at low cost

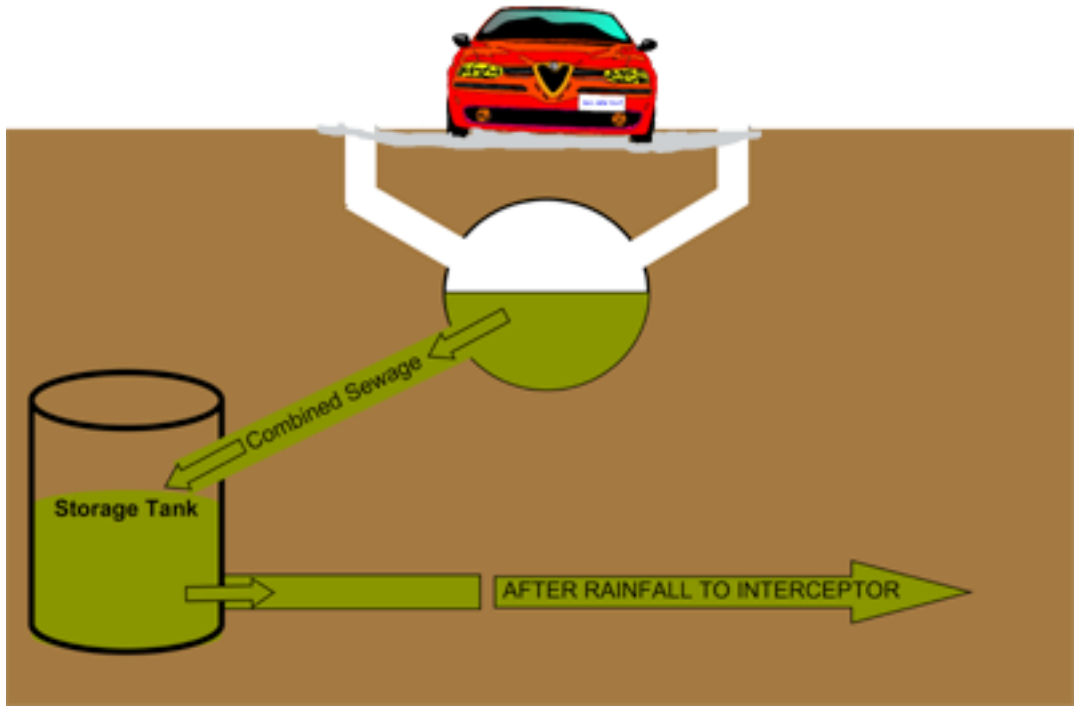


Latent In-line Storage available in relief pipes below river level

OFFLINE STORAGE - TANKS

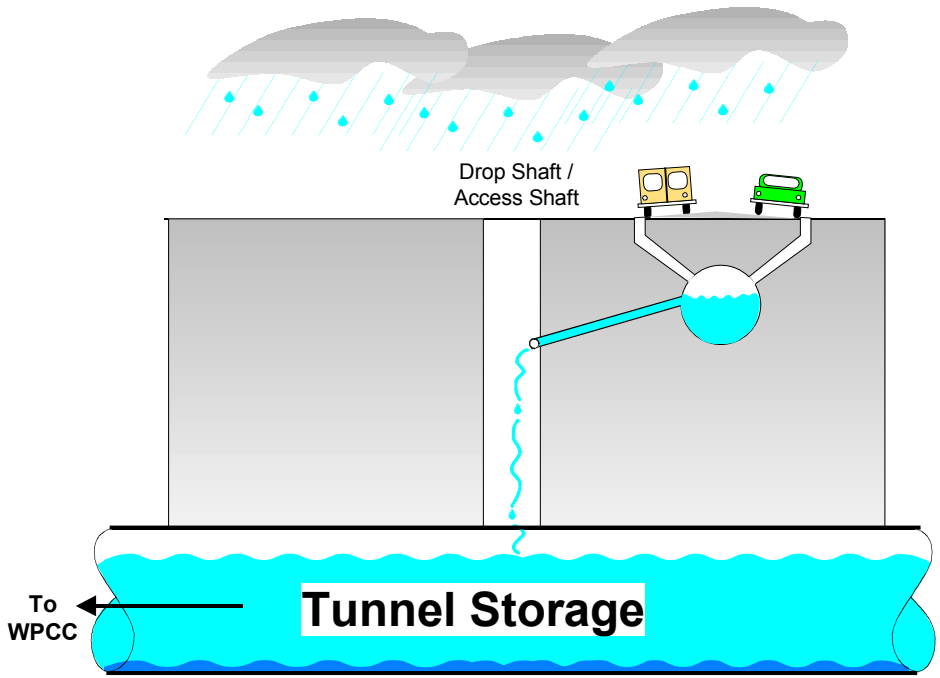
- This will comprise large, near-surface tanks located at the end of the combined sewer trunks

- **This method is used in Saginaw, Mich., Toronto, Ont. and Sarnia, Ont.**



OFFLINE STORAGE - TUNNELS

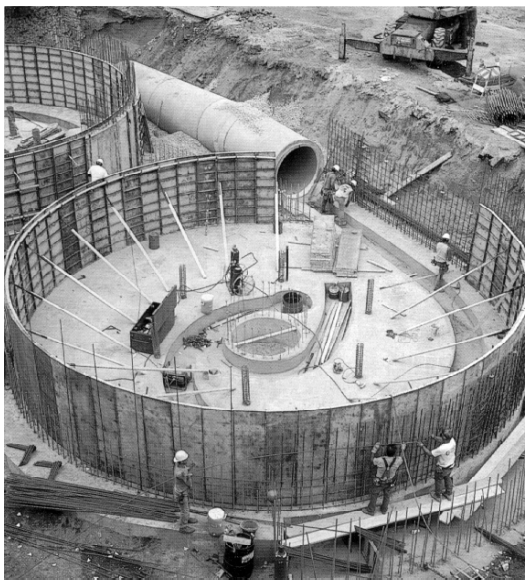
- Large tunnels could be used to store combined sewage



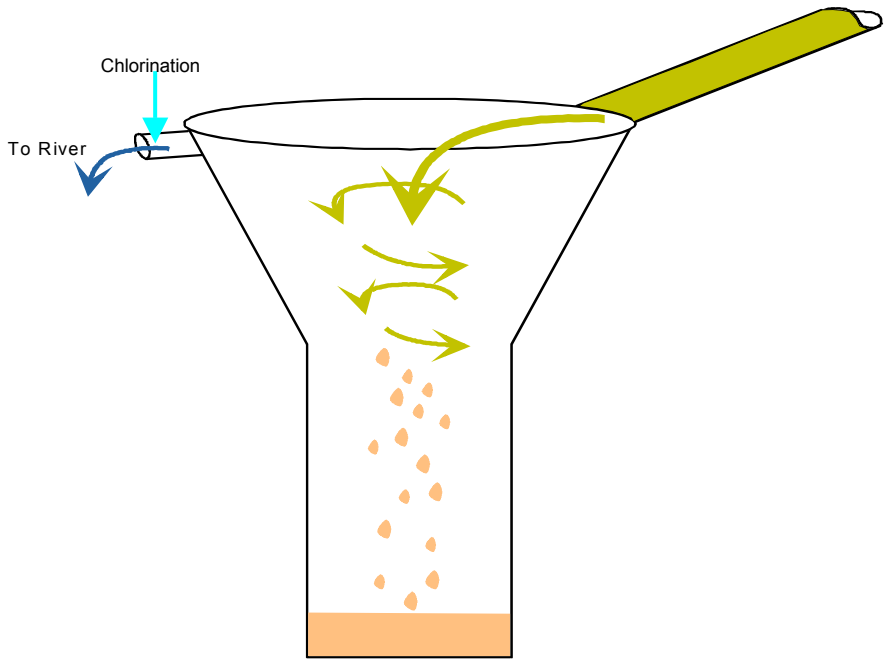
- **This method is used in Chicago, Ill.**

END OF PIPE TREATMENT

- Overflows can be treated
  - Very costly
  - Requires chemicals at many outfall locations
  - NOT recommended

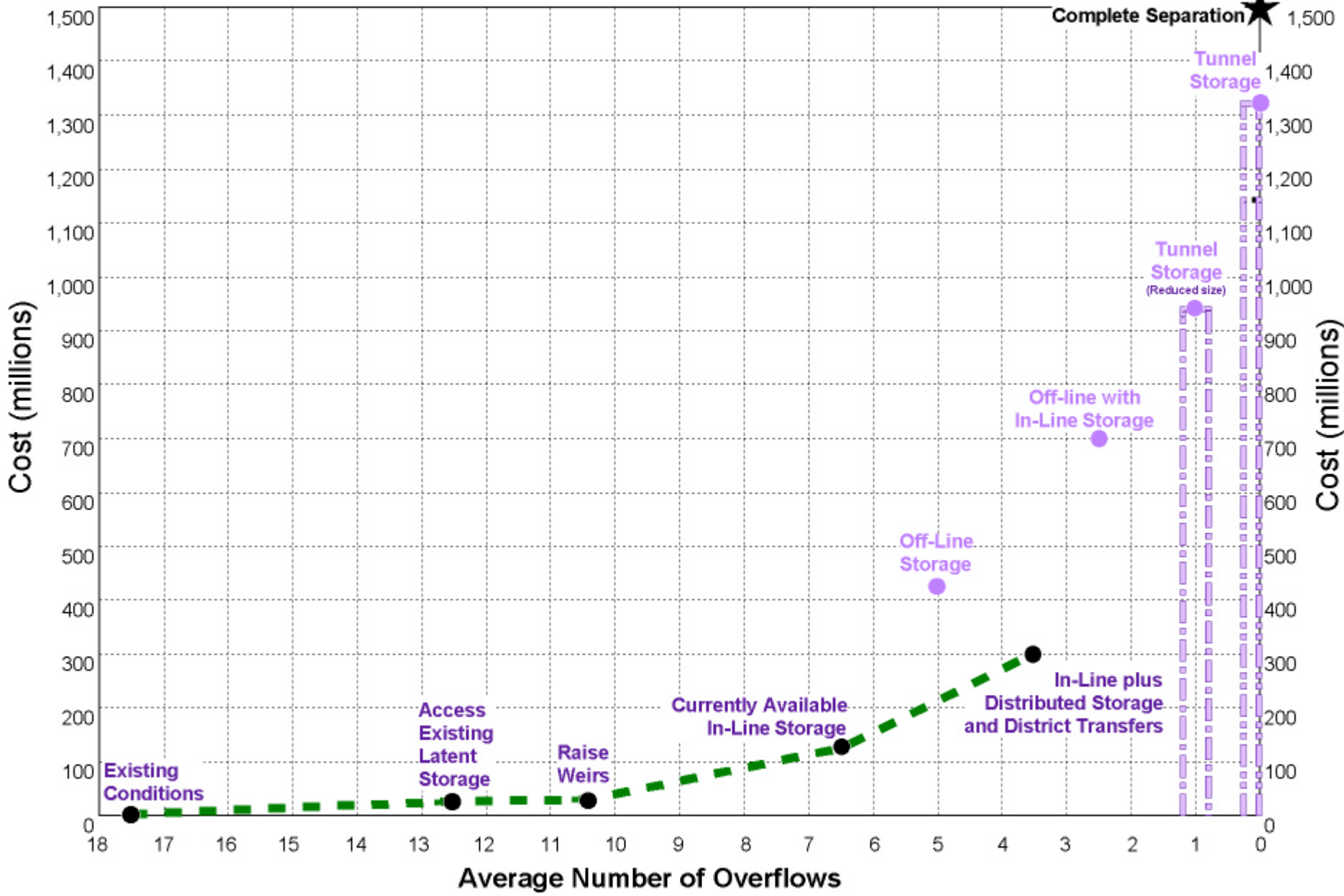


Vortex Solids Separator



COST CONSIDERATIONS

- CSO control is very costly
  - The greater the degree of control the higher the cost
- Most cost-effective options involve use of storage, especially in-line storage


Complete Separation
Tunnel Storage
Tunnel Storage (Reduced size)
Off-line with In-Line Storage
Off-Line Storage
In-Line plus Distributed Storage and District Transfers
Currently Available In-Line Storage
Raise Weirs
Access Existing Latent Storage
Existing Conditions
Cost (millions)
Cost (millions)
Average Number of Overflows
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0

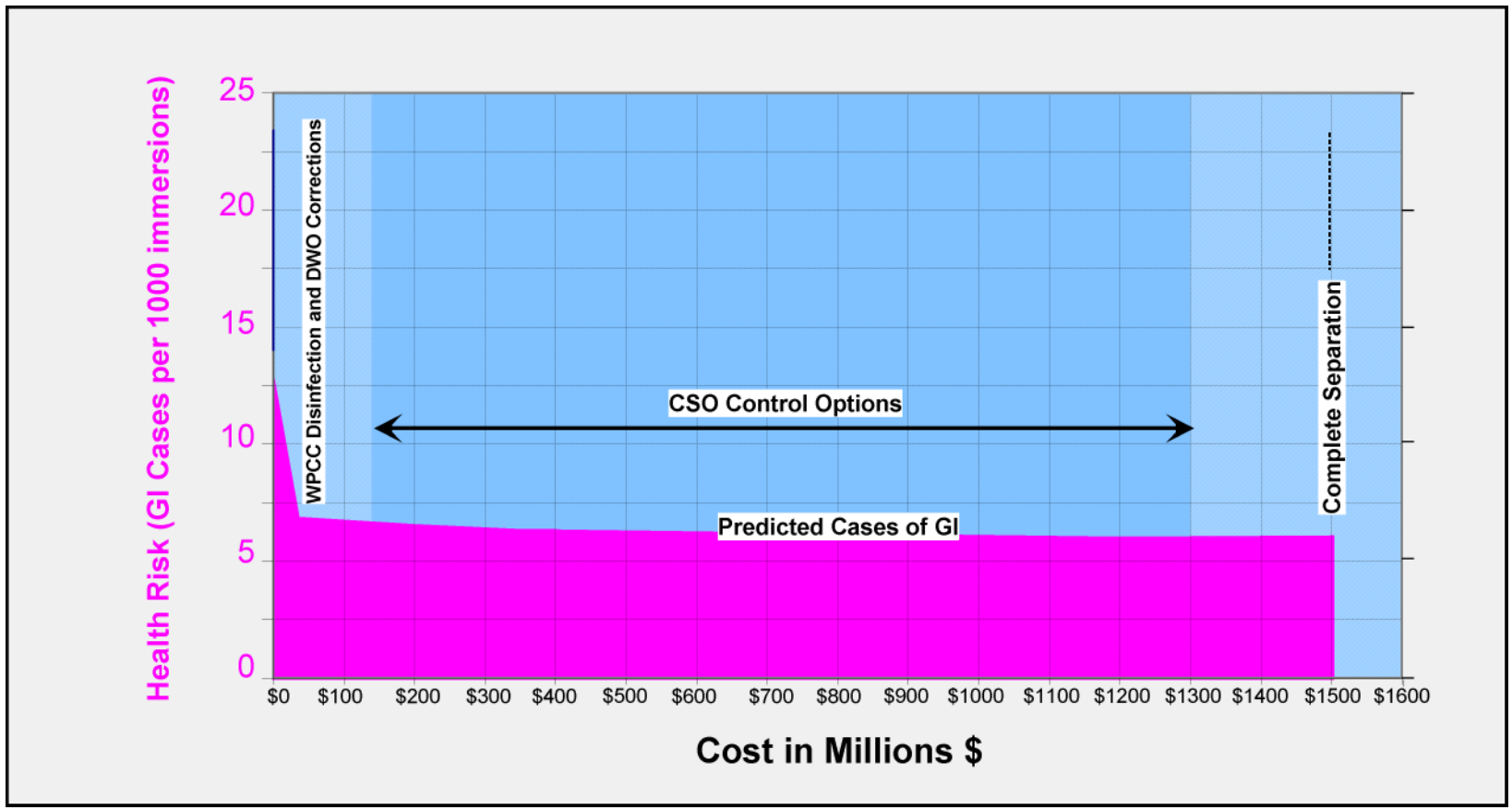
BENEFITS OF CSO CONTROL

- CSOs are not a major public health issue
- CSO control will result in a modest improvement in compliance with MSWQO after effluent disinfection
- Floatables control provides the possibility to improve river aesthetics at points of particular interest
  - (e.g., The Forks)
- Improved CSO control will contribute to the general "wellness" of the community primarily through an improved perception of river quality

ILLNESS RISK

- Estimated Gastro-intestinal Illness (GI) Cases from Recreational River Use
  - Worst case projection in river conditions **before** WPCC effluent disinfection 80-200/yr
  - **After** effluent disinfection 40-90/yr
- Expected GI caseload for Winnipeg from all other sources is 500,000 to 1,000,000/yr

EFFECT ON ILLNESS RISK



ILLNESS RISK

The CSO Advisory sub committee concurred with the following:

"CSO control will be costly and the benefits are subjective…. The weight of the evidence and analysis indicates CSO control should not be considered a significant public health issue in the conventional context of avoiding disease. The extent of CSO control that is appropriate and acceptable to the community is fundamentally a public policy and a regulatory compliance issue."

CSO COSTS & POLICY

- CSO control is very costly, benefits difficult to quantify
- CSO control is essentially a public policy, environmental policy issue
- Practice is for Cities to implement a site-specific long-term CSO control

OTHER EXPERIENCE

US Environmental Protection Agency (EPA) has CSO Control Policy:

- Meet water quality standards, or:
  - limit overflows to **average of 4/year** **or** capture 85% of combined sewage during wet weather event;
  - captured flow must be given a minimum of primary treatment and disinfection
- Most States follow EPA policies
- EPA acknowledges affordability as part of the equation

USA CSO CONTROL POLICY

- The Policy contains **four fundamental principles** to ensure that CSO controls are cost-effective and meet local environmental objectives:
  - Clear levels of control to **meet health and environmental objectives**
  - Flexibility to consider the site-specific nature of CSOs and find the most **cost-effective** way to control them
  - Phased implementation of CSO controls to accommodate a **community's financial capability**
  - Review and revision of water quality standards during the development of CSO control plans to reflect the **site-specific wet weather impacts of CSOs**

OTHER EXPERIENCE

- **Ontario (Draft Policy)**
  - Capture 90% combined sewage and provide primary treatment
  - Average 3-5 overflows, 2 at beaches
  - Meet guidelines for 95% of time at beaches
  - The emphasis appears to be on bathing beaches
- **Alberta**
  - Require CSO plan for near-term (5-25 years)
  - Outline long-term plan (25-50 years)
  - Establish general plan to achieve ultimate (50-100 years) equivalent, or better, performance to complete separation
  - Comply with primary and secondary objectives 80 and 90% of the time, respectively
- **Manitoba**
  - No CSO policy at present

Illustrative Potential Program City of Winnipeg

POTENTIAL PROGRAM ASSUMPTIONS

- Overall regional separation will not be done
- Some overflows are acceptable
- Use of existing storage is acceptable
- Will involve long-term program with progressive monitoring and review

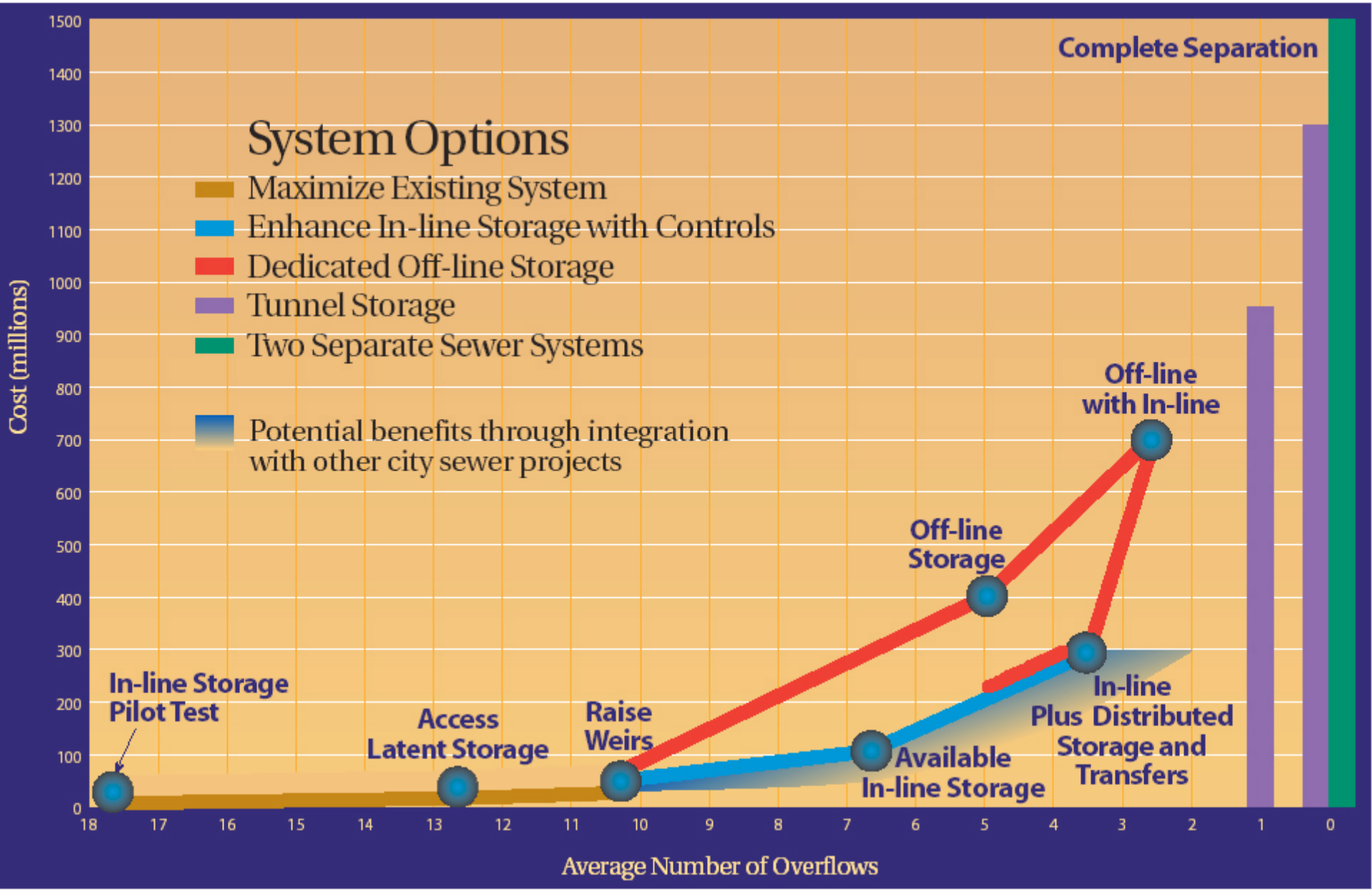
POTENTIAL PROGRAM OUTLINE

1. **Existing System Enhancements**
   - Raise diversion weirs from current 0.2 to 0.4 of the design flow height in the trunk sewers
   - Install interception and dewatering facilities in current relief pipes suitable for latent storage
   - Monitor current CSOs – frequency, duration and quality

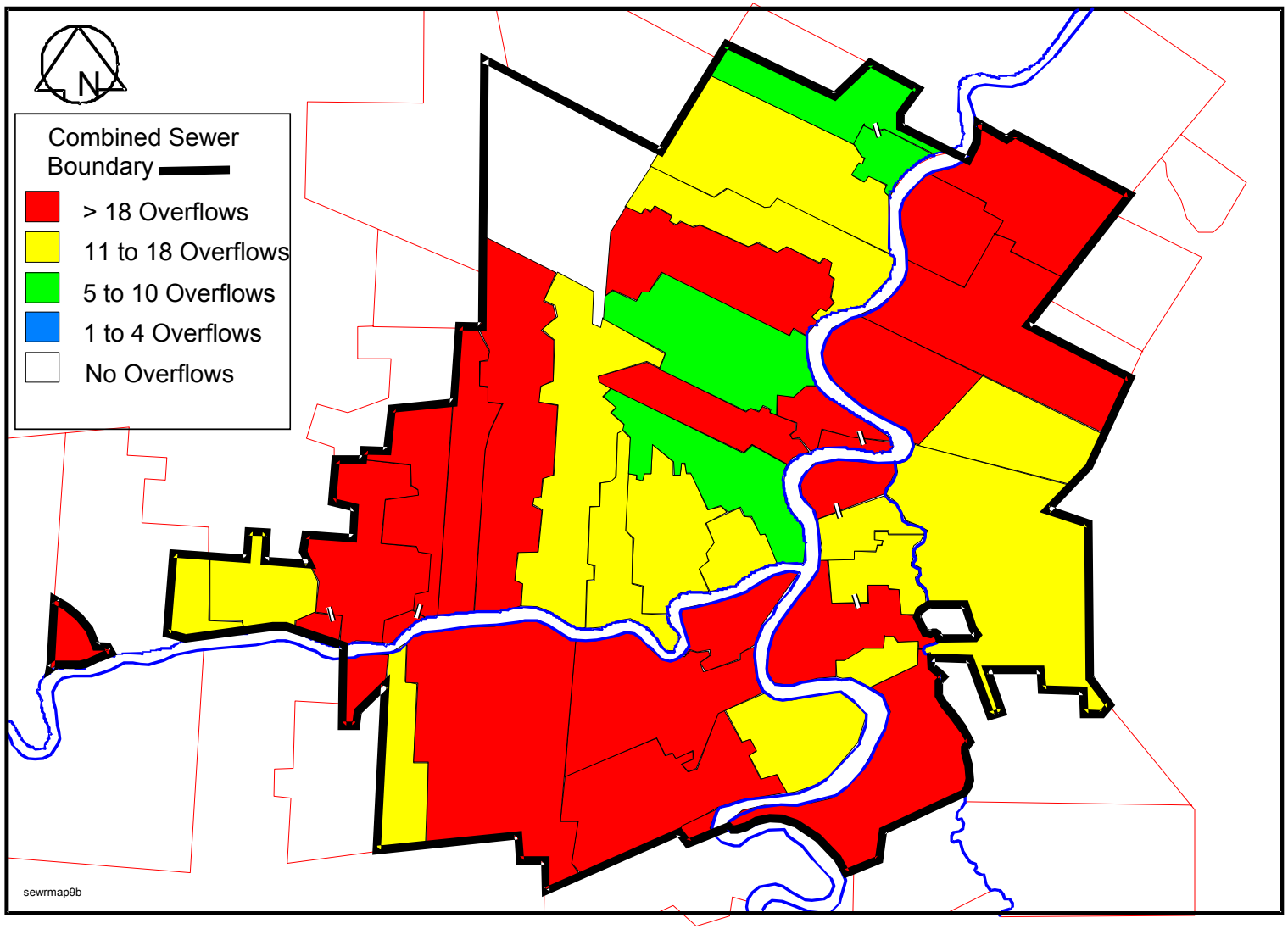
POTENTIAL PROGRAM OUTLINE

2. **New Initiatives**
   - Test In-line Storage
   - Develop In-line Storage
   - Add off-line storage tanks where in-line storage is not sufficient

POTENTIAL APPROACH IS START OF LONG-TERM PROGRAM

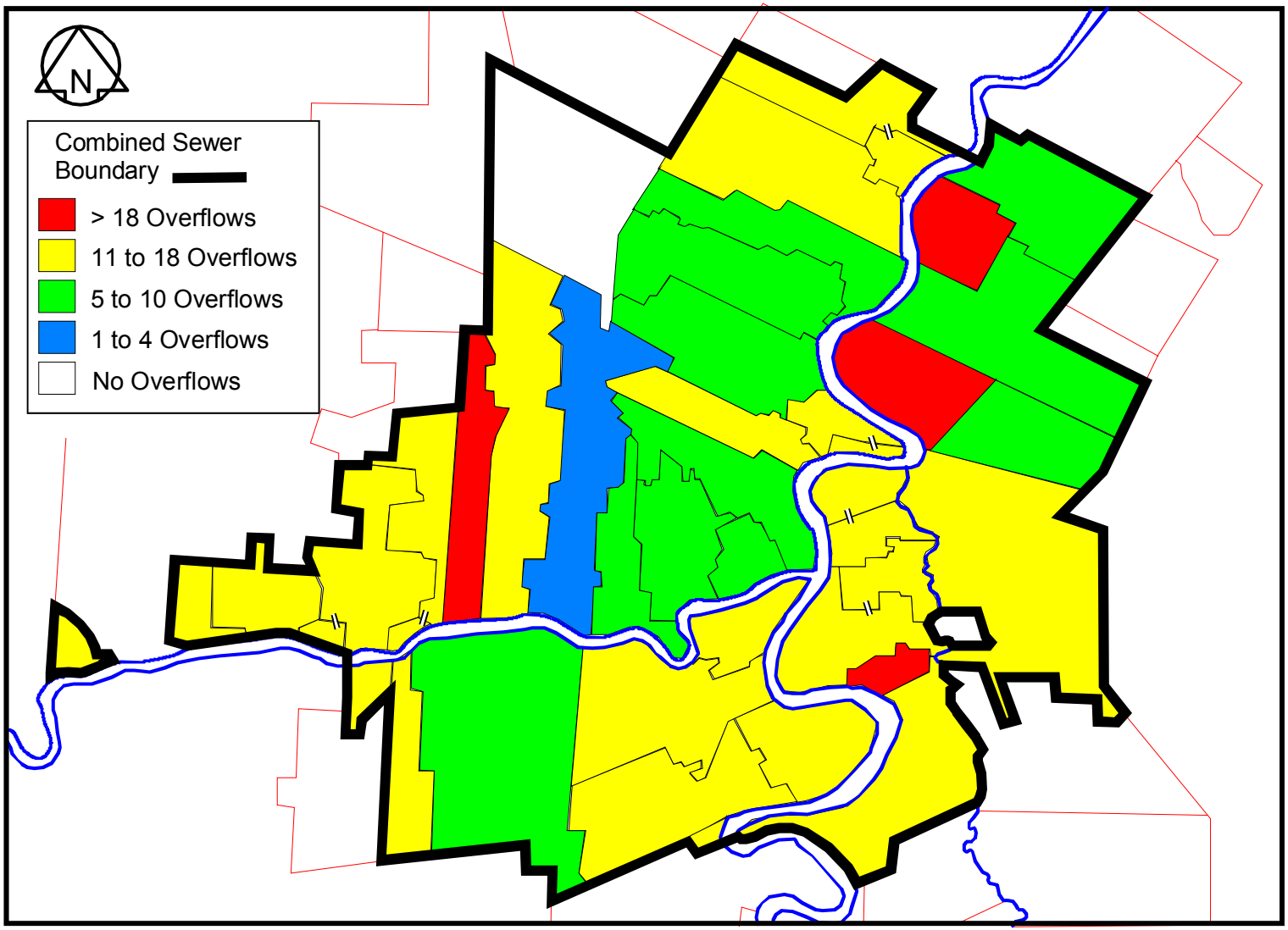


LONG-TERM: EXISTING INTERCEPTION RATE



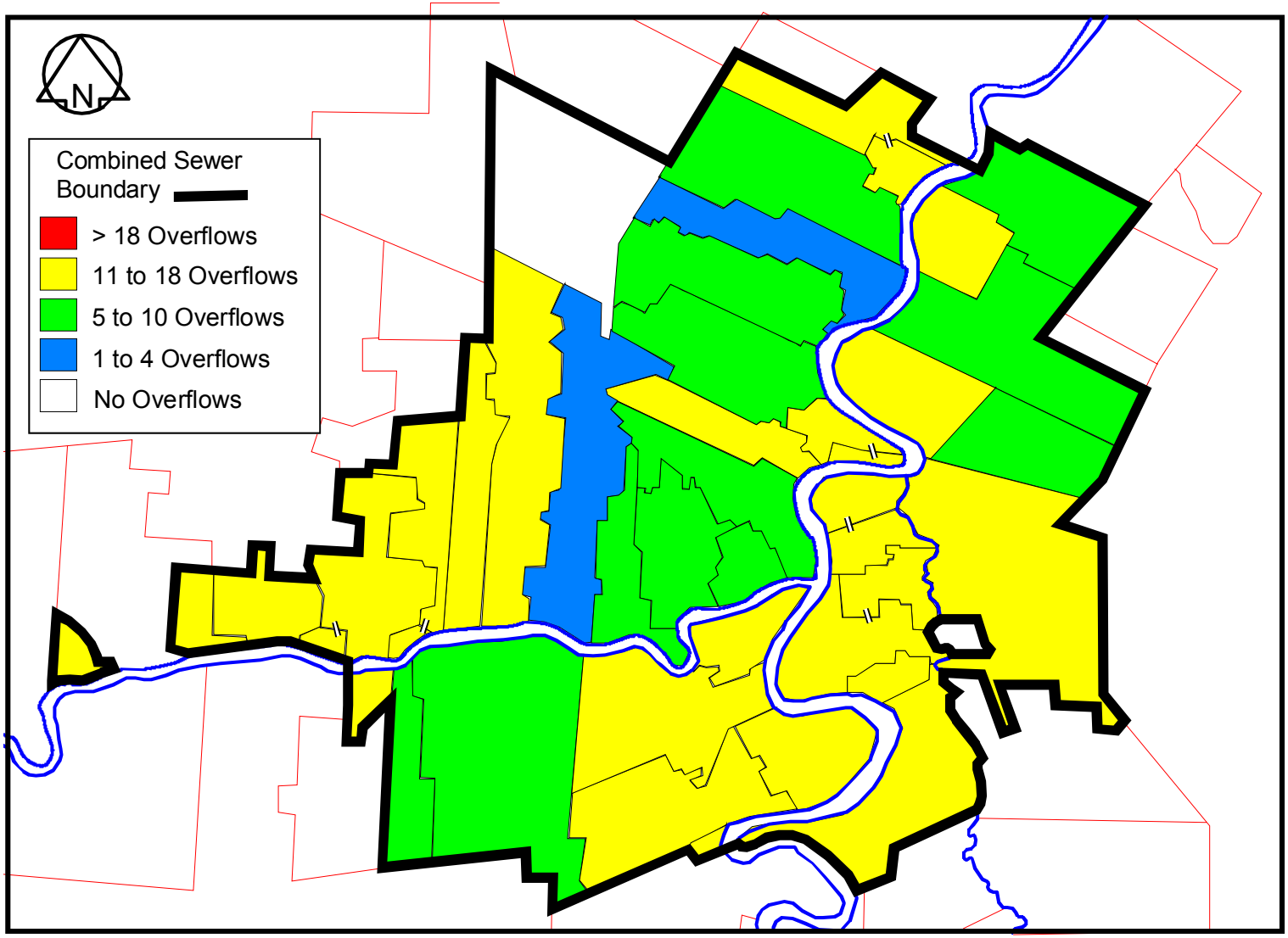
Average Annual Overflows ~ 18
Range: 7 - 30

POTENTIAL PROGRAM: MODIFIED INTERCEPTION RATE; LATENT STORAGE



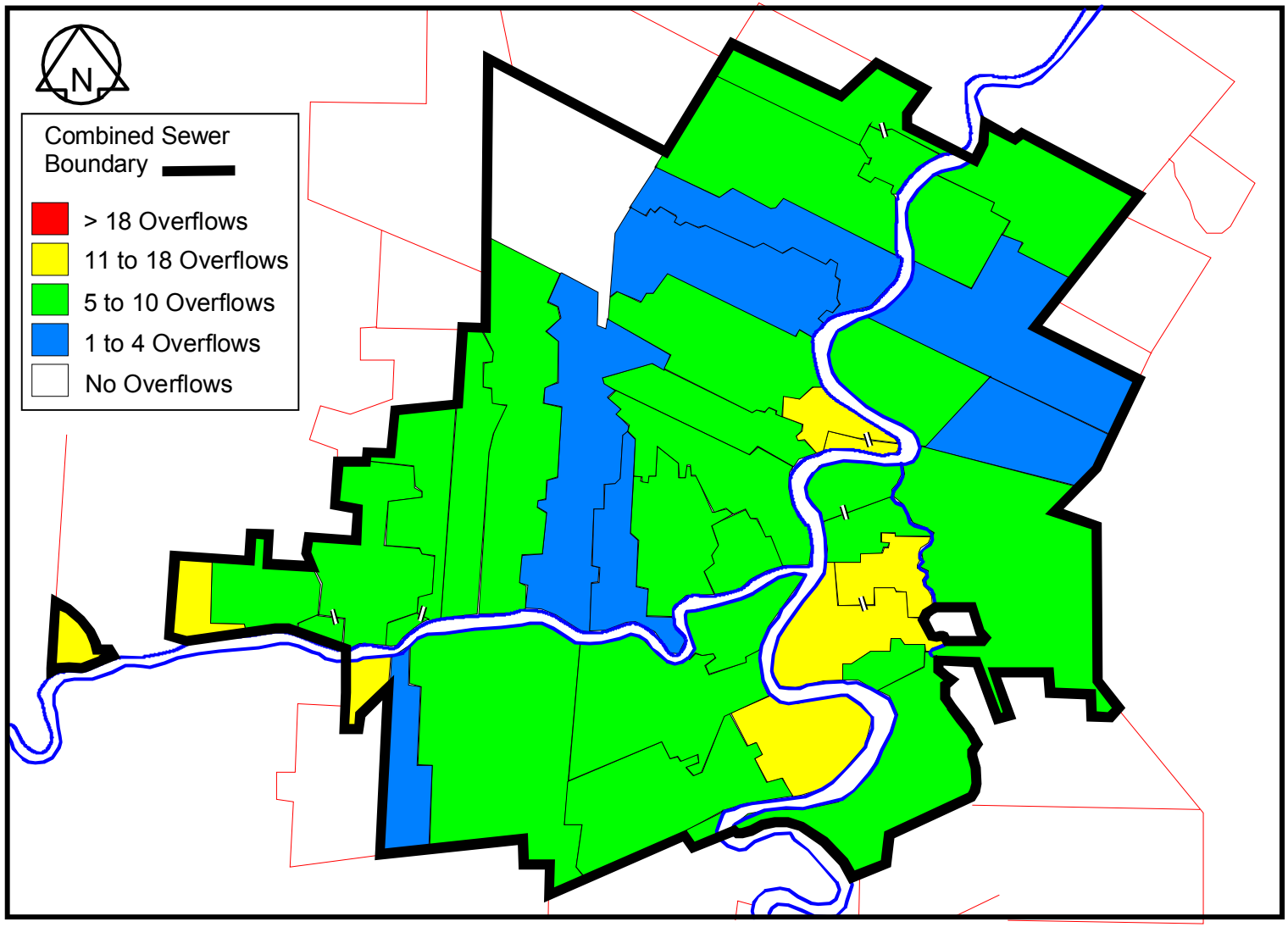
Average Annual Overflows = 12.5
Range: 3 to 22

POTENTIAL PROGRAM: MODIFIED INTERCEPTION RATE; RAISE WEIRS TO 40%



Average Annual Overflows = 10.5
Range: 2.5 to 18

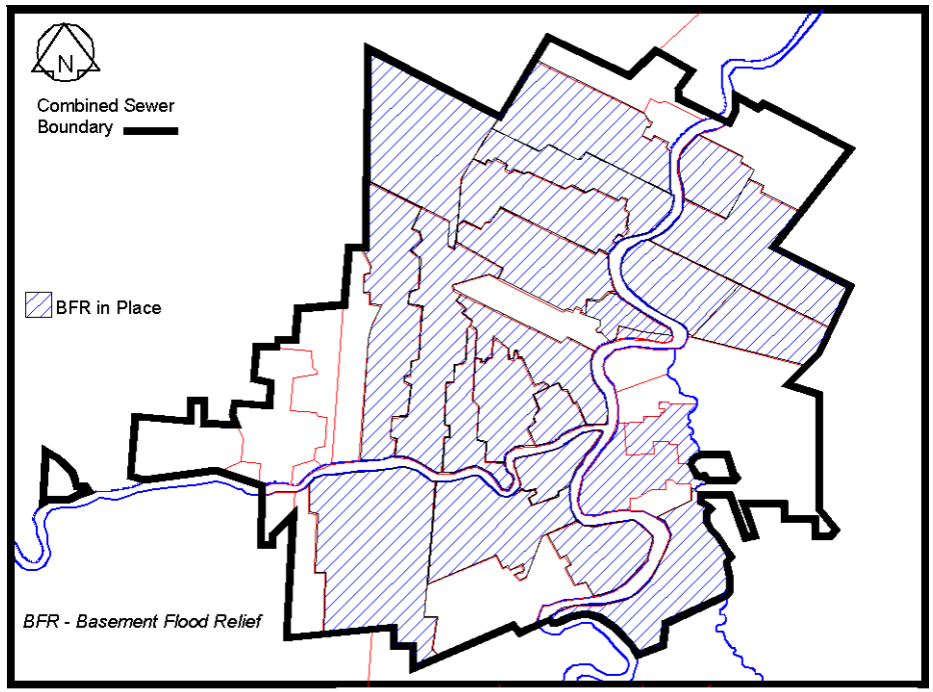
POTENTIAL PROGRAM: MODIFIED INTERCEPTION RATE; IN-LINE STORAGE



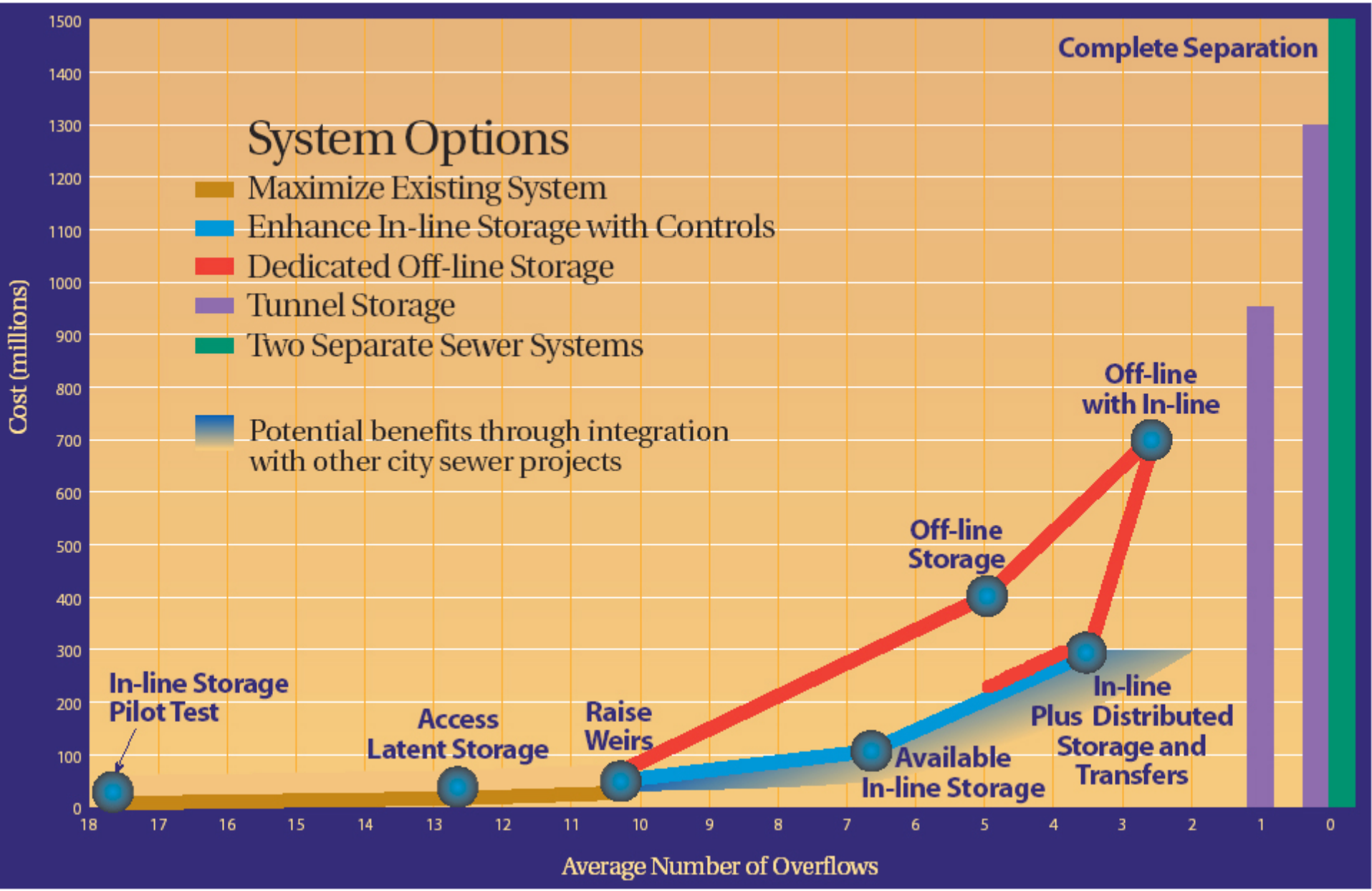
Average Annual Overflows = 7
Range: 2 to 17

OTHER CONCURRENT PROGRAMS OFFER ADDITIONAL POTENTIAL

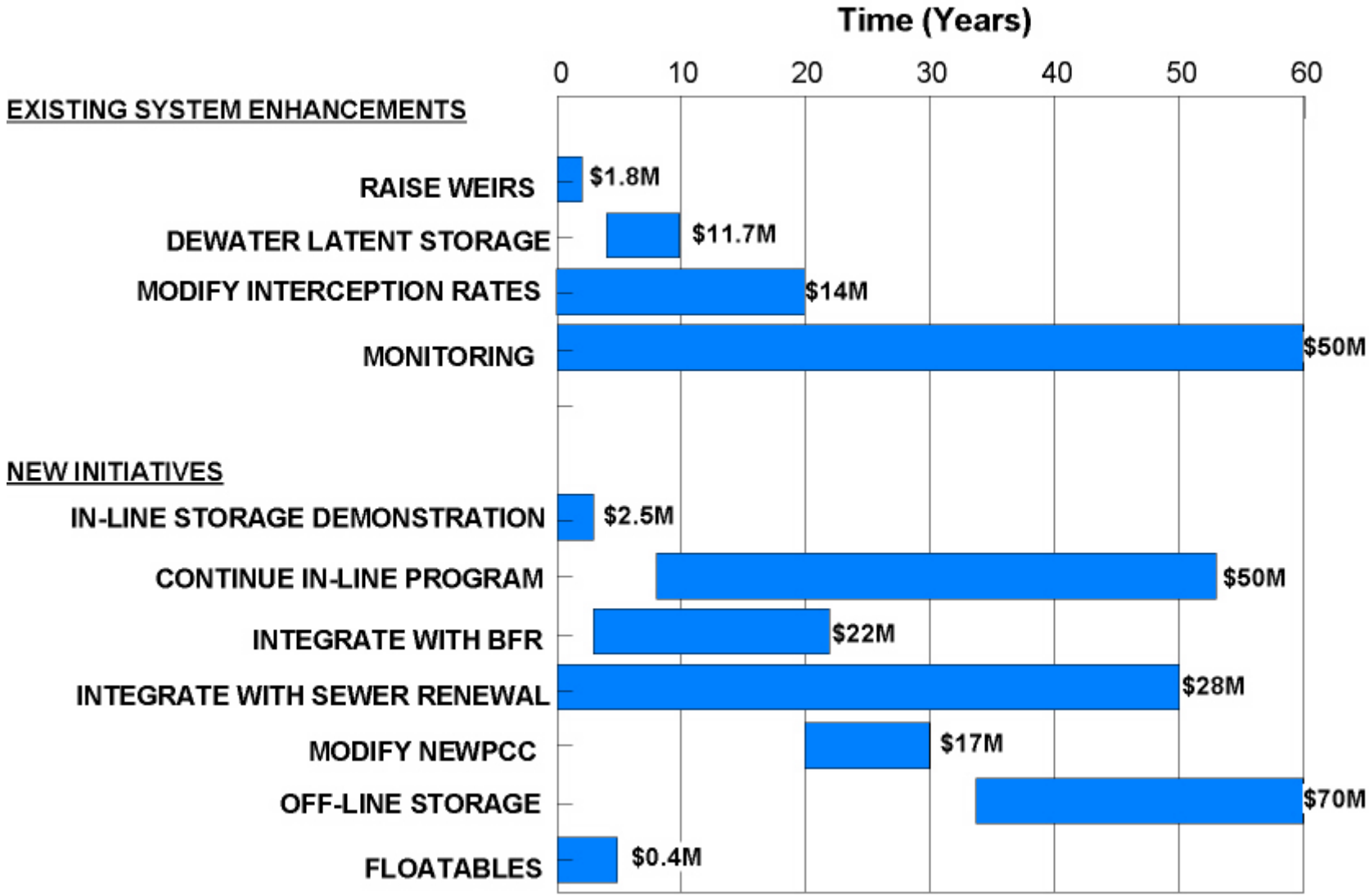
- **Basement Flood Relief**
  - ➔ ~ $110 M planned for about 13 districts
- **Combined Sewer Renewal**
  - ➔ ~ $7 M/year is planned for refurbishing old sewers
- **Potential Opportunities**
  - ➔ Oversizing of proposed relief pipes for storage
  - ➔ Allowance for localized separation
  - ➔ Oversizing/cleaning of trunk sewers for storage



POTENTIAL APPROACH IS START OF LONG-TERM PROGRAM



ILLUSTRATIVE PROGRAM



Based on $4.5M / year

Proposed CSO Program
City of Winnipeg

City of Winnipeg's Overall Plan

- Must consider CSO in context of other water quality issues
- Must consider priorities
- Must develop affordable business plan

POLLUTION PREVENTION PLAN

Combined Sewer Overflow (CSO) Control:

- Long-term CSO control program be adopted in principle to reduce overflow events
  - Citywide average of 4 events per summer recreation season reduced from 18 events
  - Within a 45 to 50 year timeframe
  - Estimated Capital Cost: $ 270 Million

POLLUTION PREVENTION PLAN

- Conceptual CSO Control Program consists of:

Year	Activity	Cost (Millions)
2002 - 05	Implement a supervisory control and data acquisition system, raise interception weirs, conduct an in-line storage demonstration project and additional engineering studies	$14
2005 - 43	Integration with basement flooding relief and sewer rehabilitation programs	$26
2028 - 33	Access existing latent and available in-line storage	$50
2034 - 50	Develop additional storage to meet long-term CSO control target of 4 CSOs per recreation season	$180

- **Program is conceptual and subject to ongoing review**

City's Proposed Plan Reflects Important Considerations

- Manitoba Conservation Guidance and Priorities
- Fiscal Responsibility
- Consistent with International prevailing practice


QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.
Thank You