Decision Support Tool for Sewer Upgrades in City of San Mateo

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SF Bay Beaches Bacteria TMDL Implementing Parties Meeting
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12:00-1:30 PM
San Francisco PUC

LARRY WALKER ASSOCIATES

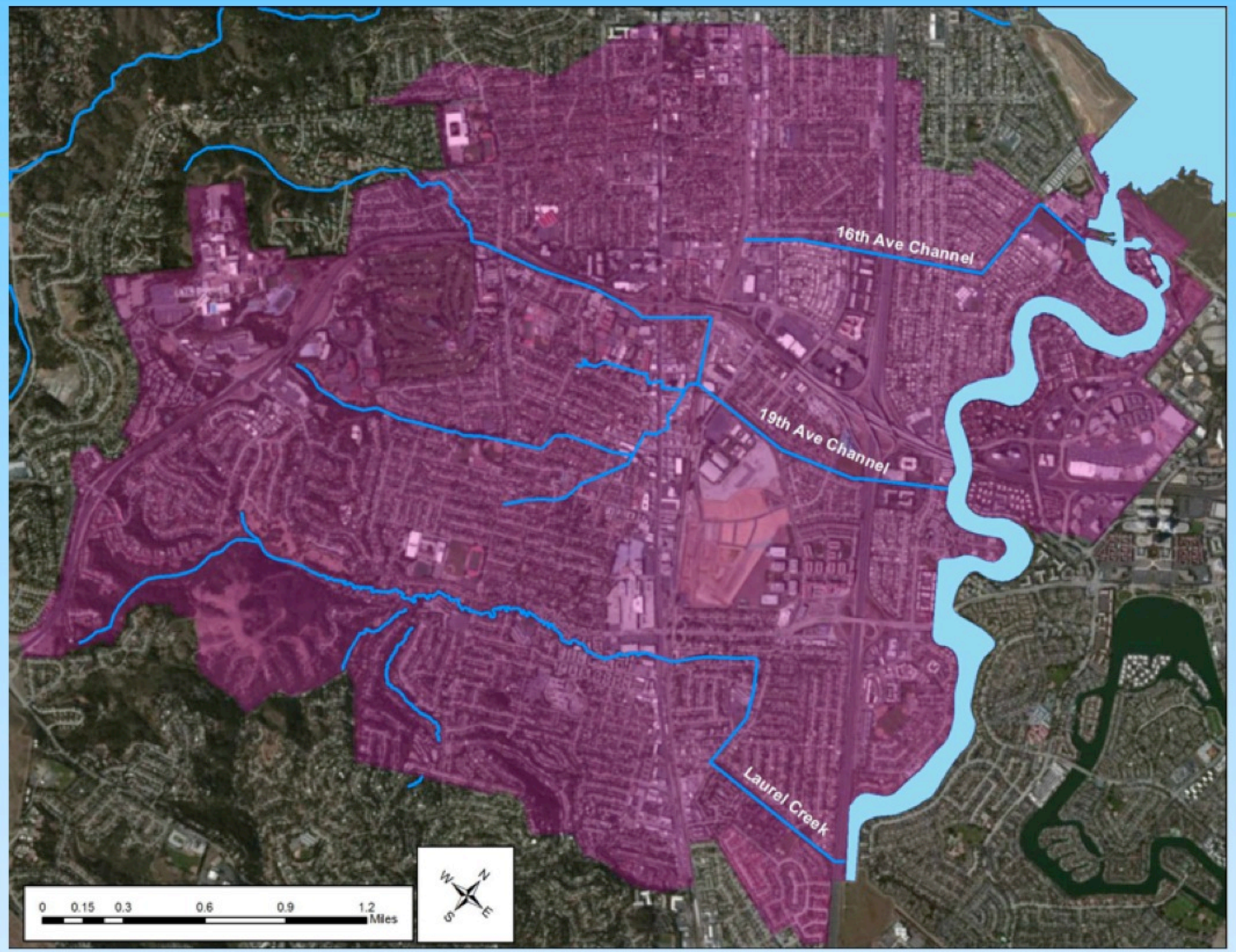
Talk Outline

- Context and Goals
- Overall Technical Approach
- Data Provided
- Derivation of Scores
- “Querying the Tool”
- Caveats

Context and Goals

Context

- City is complying with 2009 Cease & Desist Order regarding SSOs.
- Marina Lagoon is included in San Franciso Bay Beaches Pathogen TMDL.
- Regional Board considers sewer leaks and overflows among the pathogen sources to Marina Lagoon.
- Per the TMDL, City is required to prioritize sewer system inspections and repairs in areas within ¼ mile of the beach to the extent possible within CDO framework.



Stormwater drainage area affecting Marina Lagoon (red shading)

Context and Goals

Goals

- Develop communication tools using disparate sources of data that can assist discussions about sewer upgrades – especially as regards pathogen transfer to Marina Lagoon and general risk of Infiltration/Exfiltration (I/E)

- Make recommendations for further investigations (wont cover this today)

Overall Technical Approach

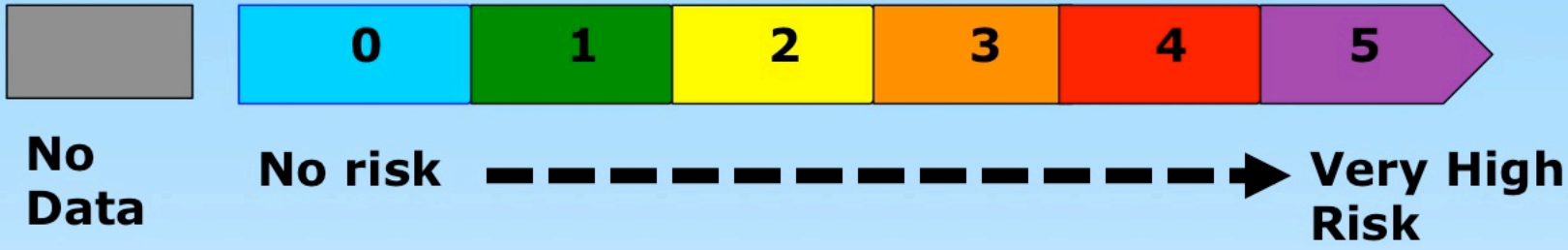
- Develop scores for individual sewer mains using factors that reflect **risk of localized cross contamination** between sewer mains and nearby storm drains

- Integrate scores into **a spatial tool** that others can use to customize queries and maps:

  "Show me the location of all sewer pipes that have characteristic A and B"

Overall Technical Approach

- Use data that can be georeferenced and which apply to individual sewer mains
- Convert all types of data into scores from 0-5

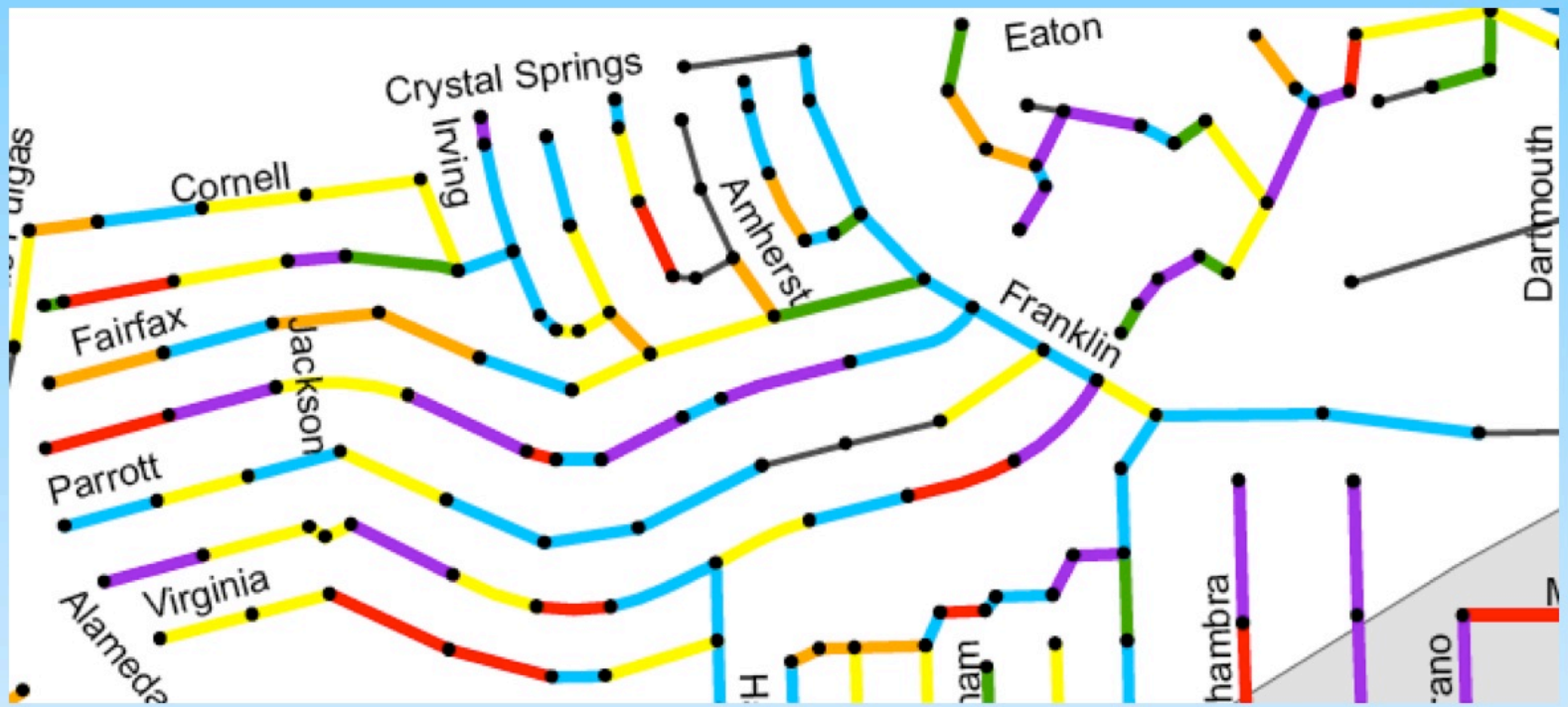


Allows for:

- Simple communication
- Display results using heat maps
- Easy queries of the geodatabase

"Show me the location of all sewer pipes that have scores of 3-5"

Overall Technical Approach



No Data

No risk → **Very High Risk**

Data Provided

- Spatial datasets (ArcGIS shapefiles)
  - Marina Lagoon & SF Bay
  - Urban Creeks and Canals
  - Drainage areas for Storm Drain Networks
  - Lift Stations and Pump Stations
  - Storm Drain Catch Basins
  - Storm Drain Main Lines
  - Storm Drain Manholes
  - Sanitary Sewer Main Line
  - Sanitary Sewer Manholes
  - Some CCTV inspection results
- Excel files with CCTV inspection results
- Sewer Infrastructure Block Map Book
- Manhole conductivity survey from October 2014

Derivation of Scores

Pipe characteristics used

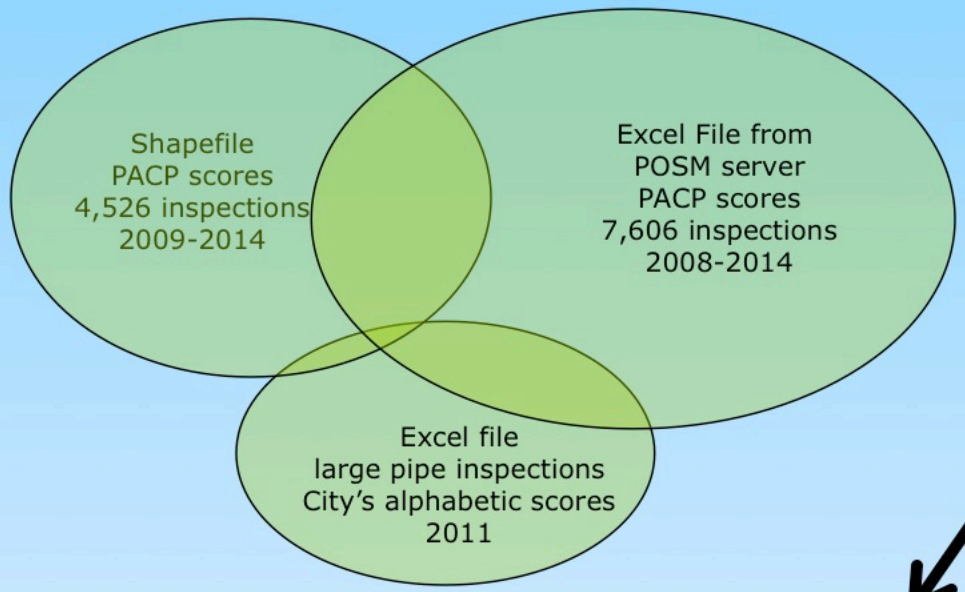
Characteristics of Sewer Mains
Physical pipe defects from CCTV inspections: • PACP* structural defect scores (cracks, fractures, etc.) • PACP* maintenance defect scores (deposits, root intrusion) • City's alphabetic condition scores (for some large diameter pipes)
Horizontal proximity to storm drains
Conductivity of sewage

*Pipeline Assessment & Certification Program by NASSCO (National Asociation of Sewer Service Companies)

Derivation of Scores

Physical Pipe Defects

CCTV Inspection Results



Steps to Reconcile Files

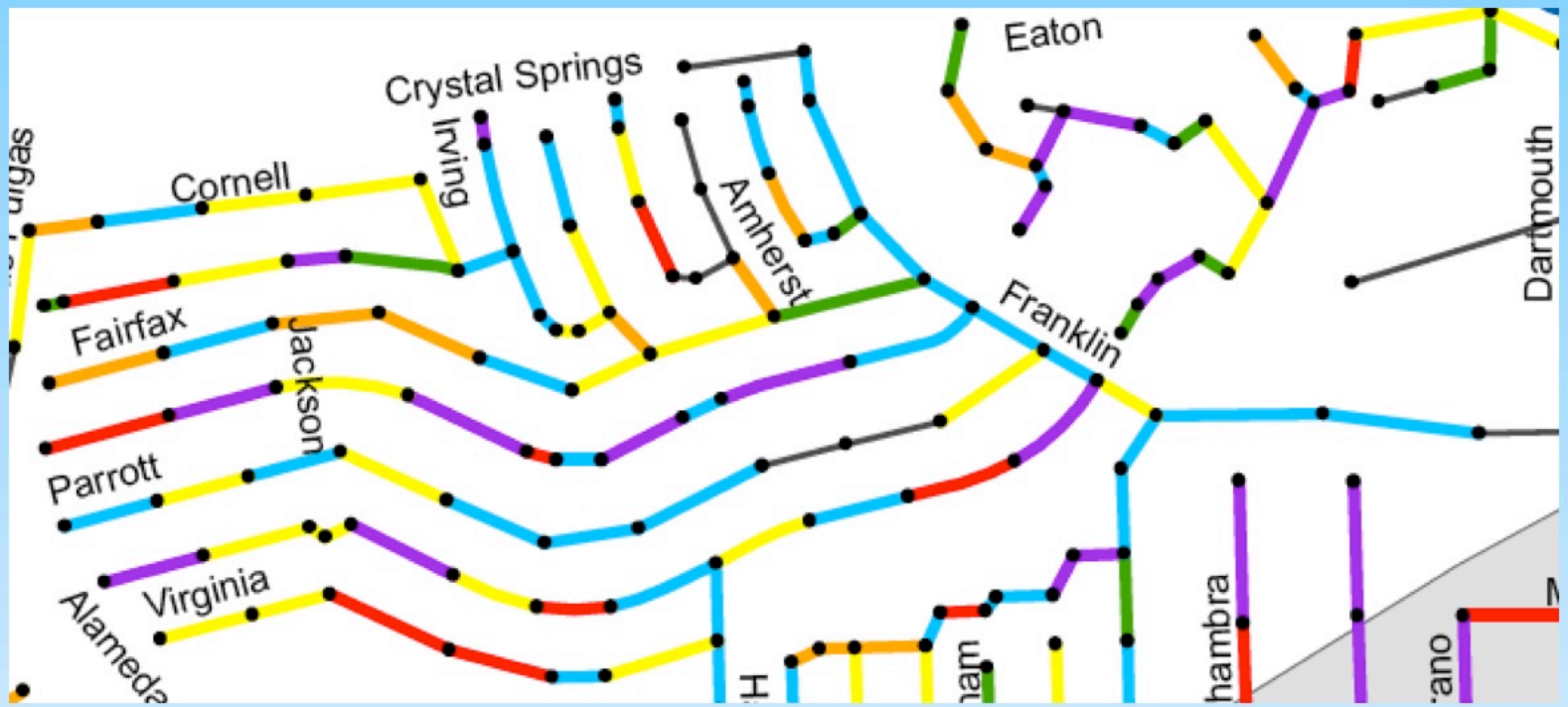
1. Address Facility ID discrepancies
2. Identify mappable assets
3. Merge data sets
4. Identify and retain most recent inspection per asset
5. Assign 0-5 scores to pipe

Three Resulting Criteria

- Pacp_Struct (grade of most severe structural defect)
- Pacp_Maint (grade of most severe maintenance defect)
- LgPipeScor (converted alphabetic scores to numeric)

Derivation of Scores

Physical Pipe Defects



No Data

No risk → **Very High Risk**

Proximity to Storm Drains

Scores were developed for three populations of storm drains:

1. All storm drains in the area of interest
2. "Floodable" storm drains
3. Perforated storm drains

Derivation of Scores

“Floodable” storm drains

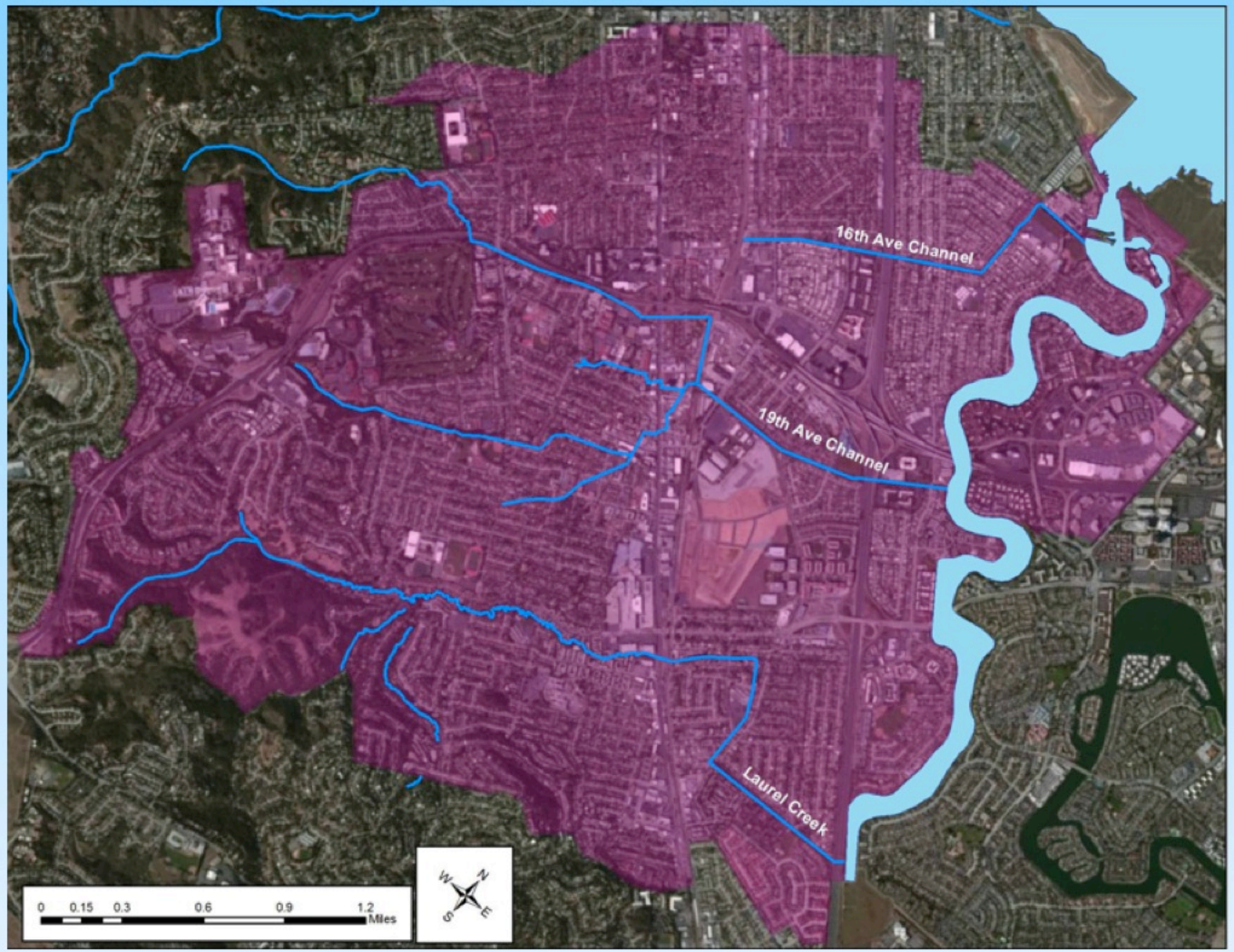
For this project, “floodable” means drains that can fill with Marina Lagoon water

Will probably fill with water when lagoon is at high stage

Probably too high

Derivation of Scores

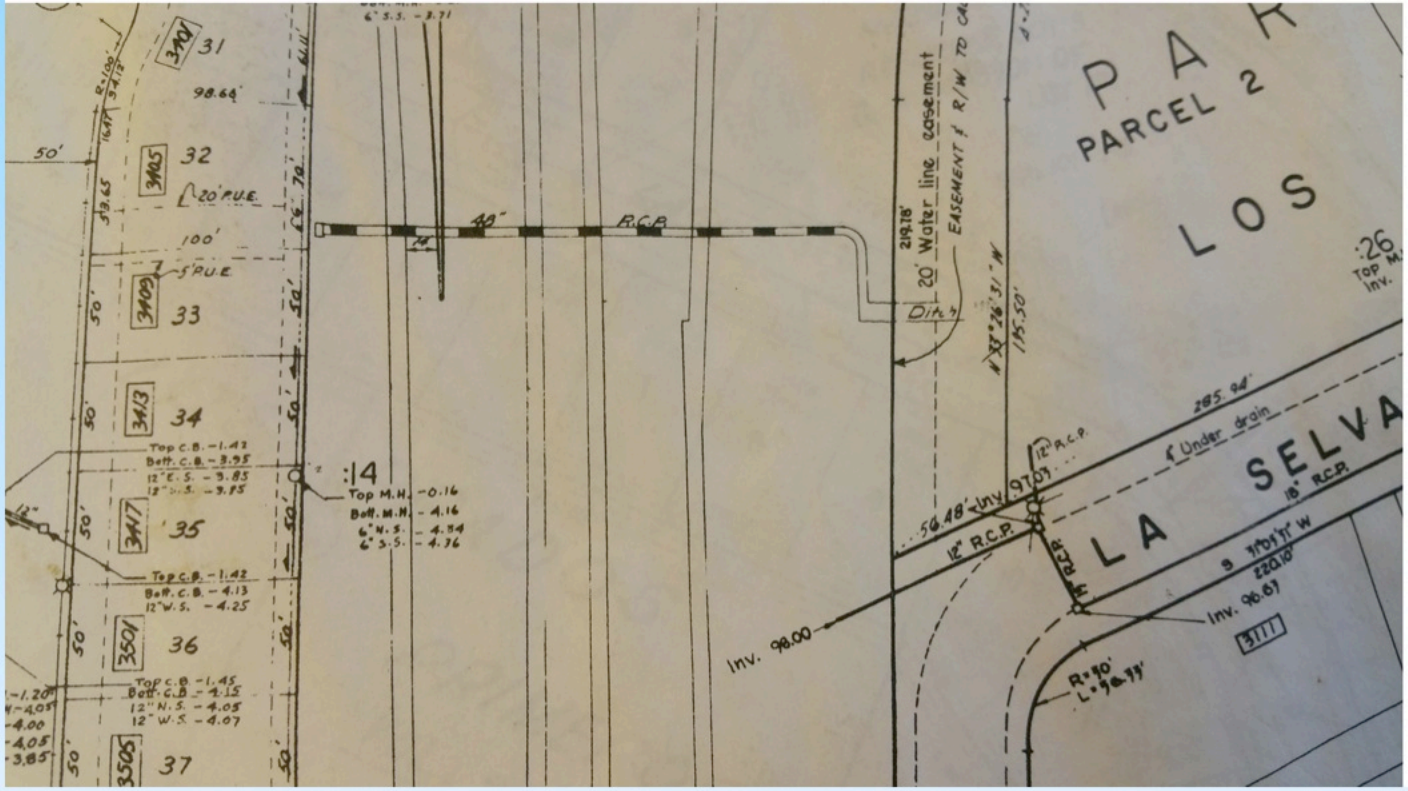
"Floodable" storm drains



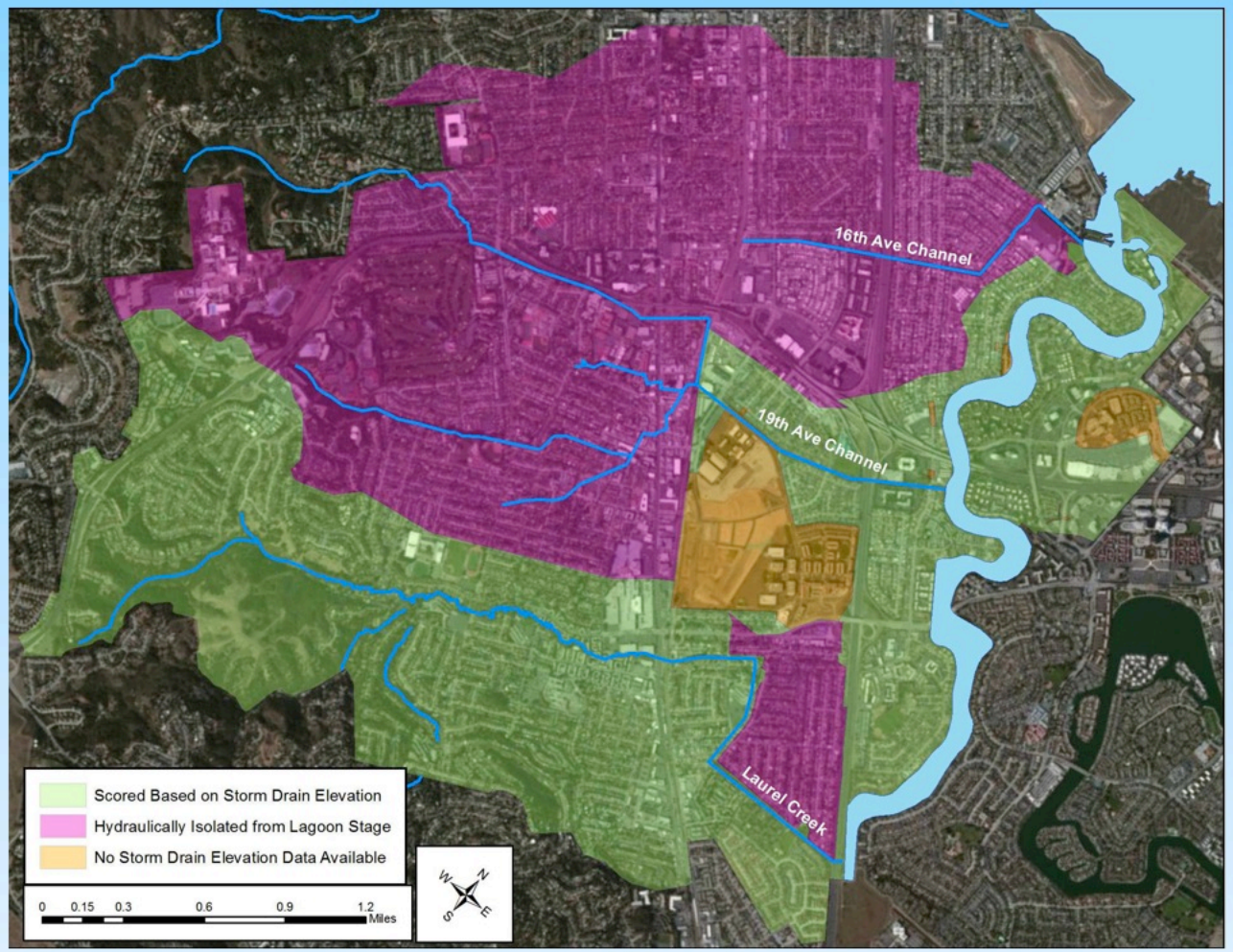
Boundary of MS4 that ultimately drains to Marina Lagoon

Derivation of Scores
“Floodable” storm drains

Several hundred elevations from the Block Map book were used to identify “floodable” storm drains



Derivation of Scores
"Floodable" storm drains

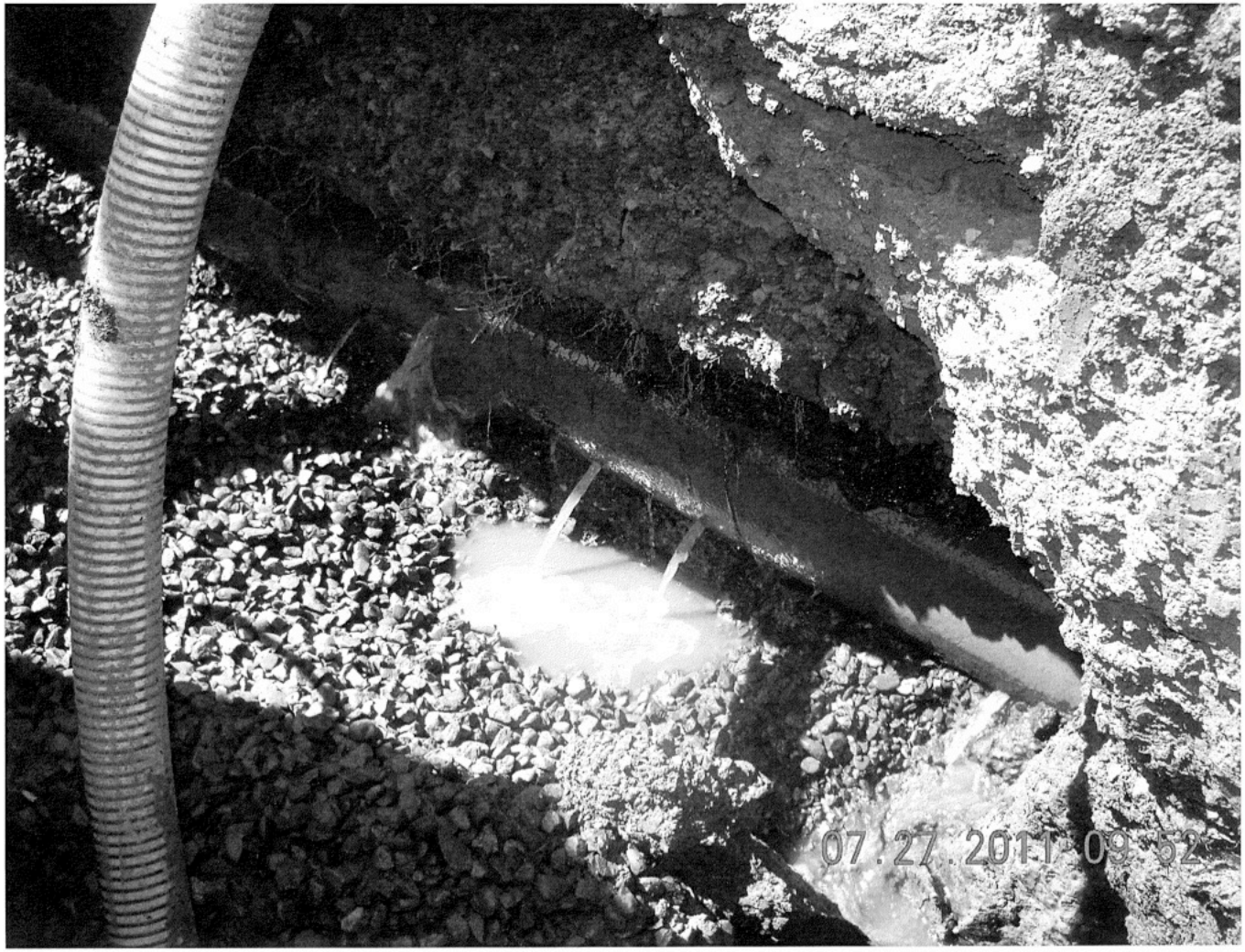


Storm drains in **pink area** do not communicate with lagoon stage

Storm drains in **orange area** do not have elevations in Map Book

Derivation of Scores

Perforated storm drains



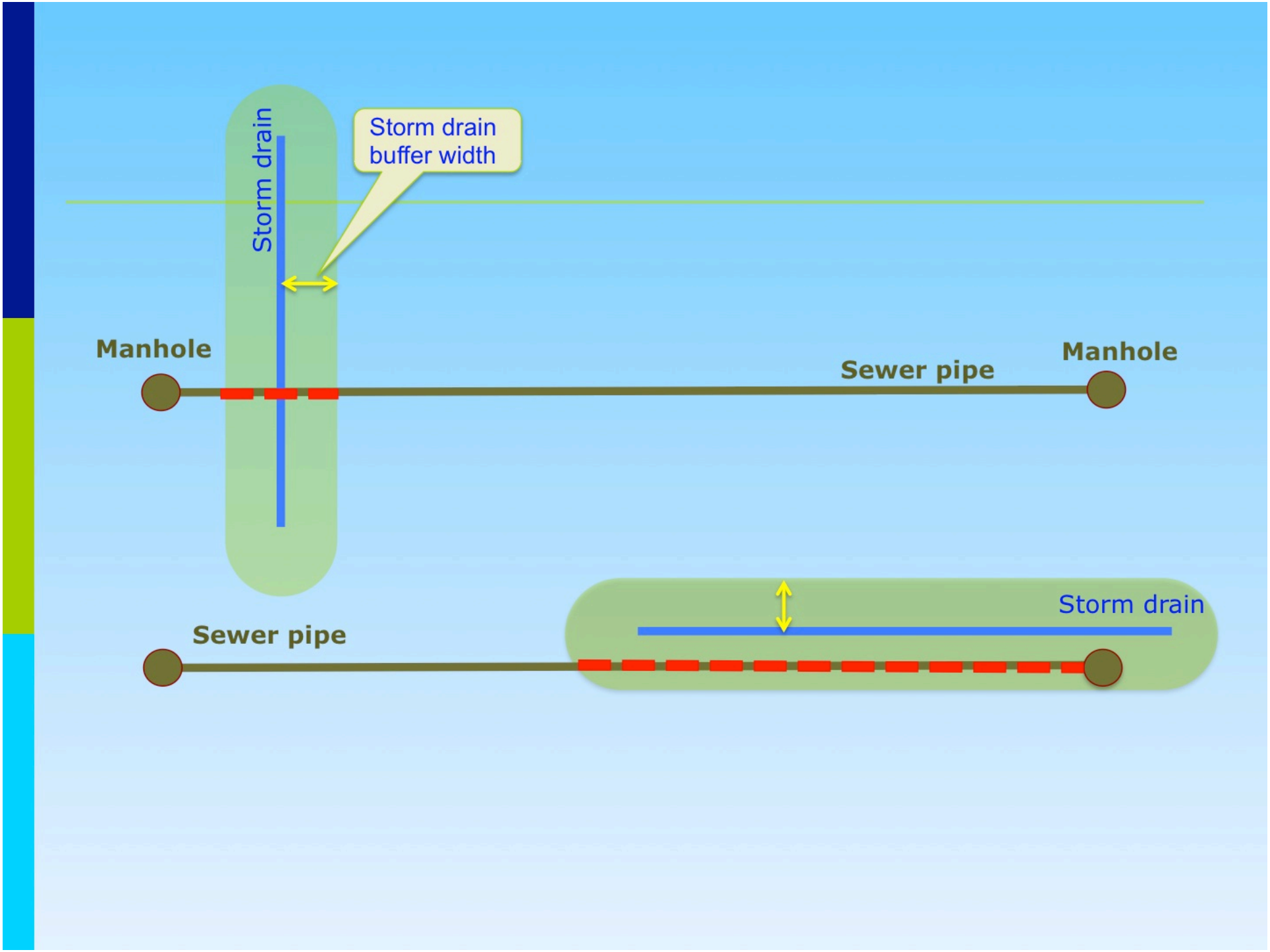
Derivation of Scores

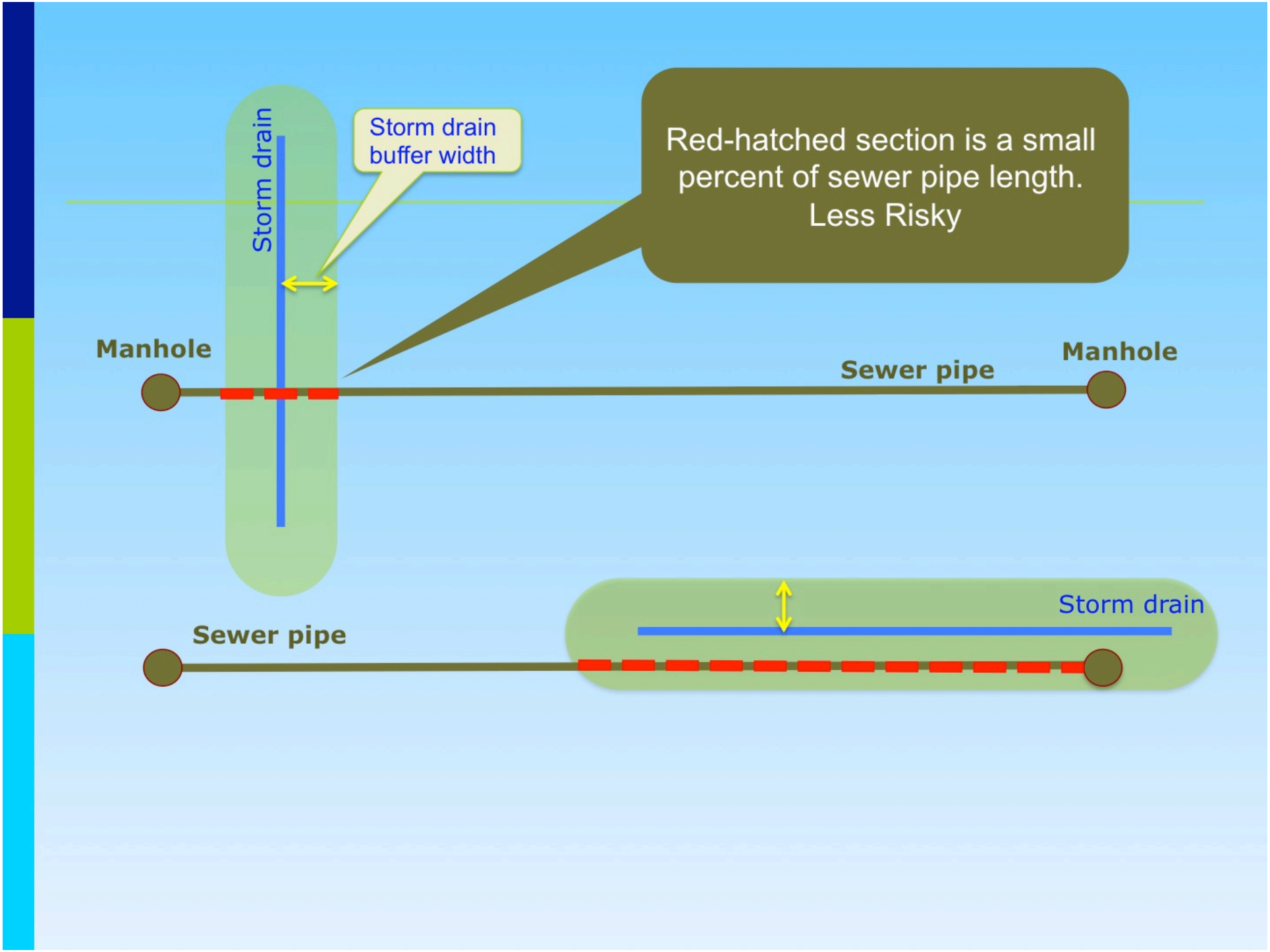
Proximity to Storm Drains

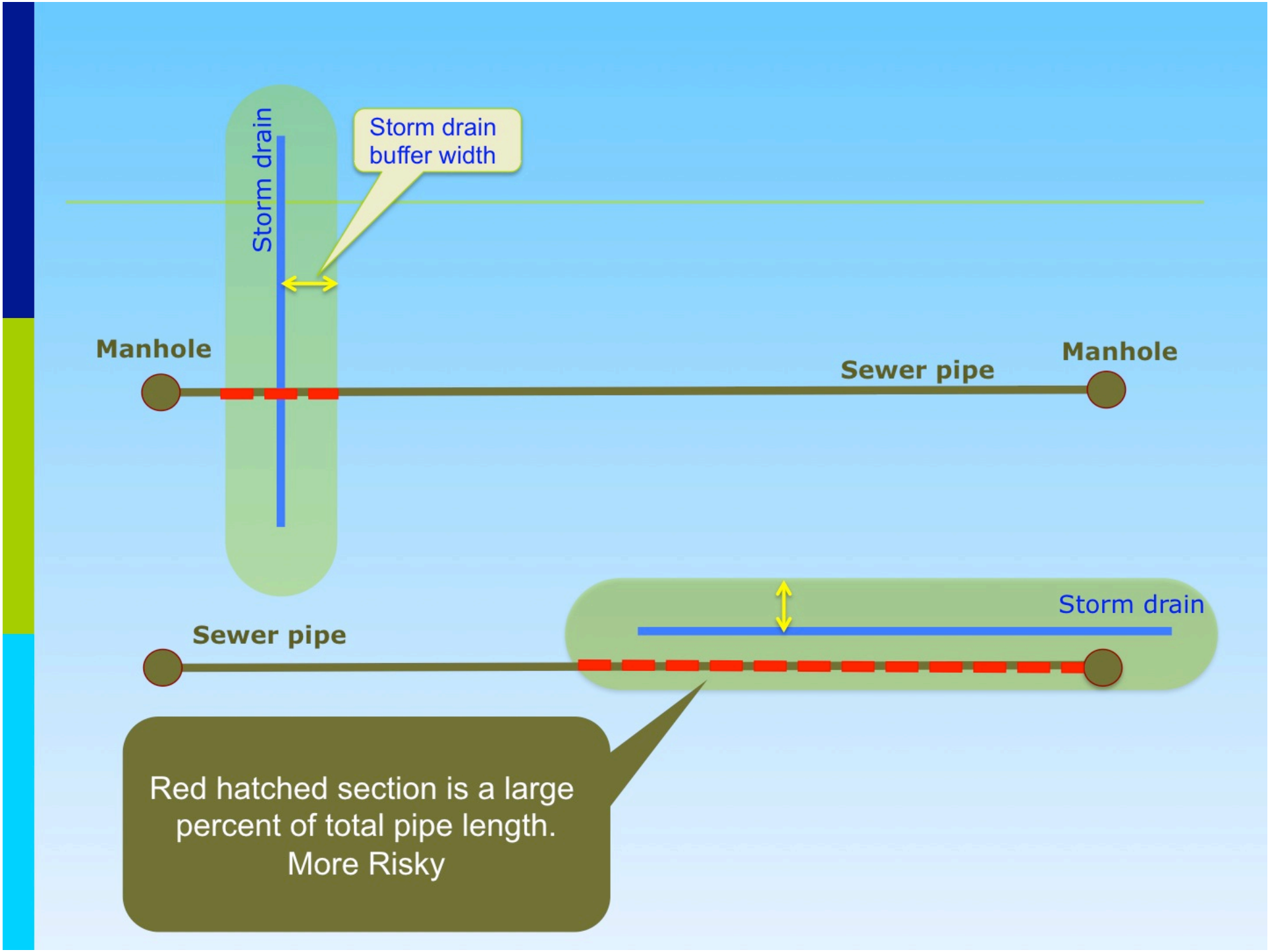
1. Draw a horizontal buffer around storm drains

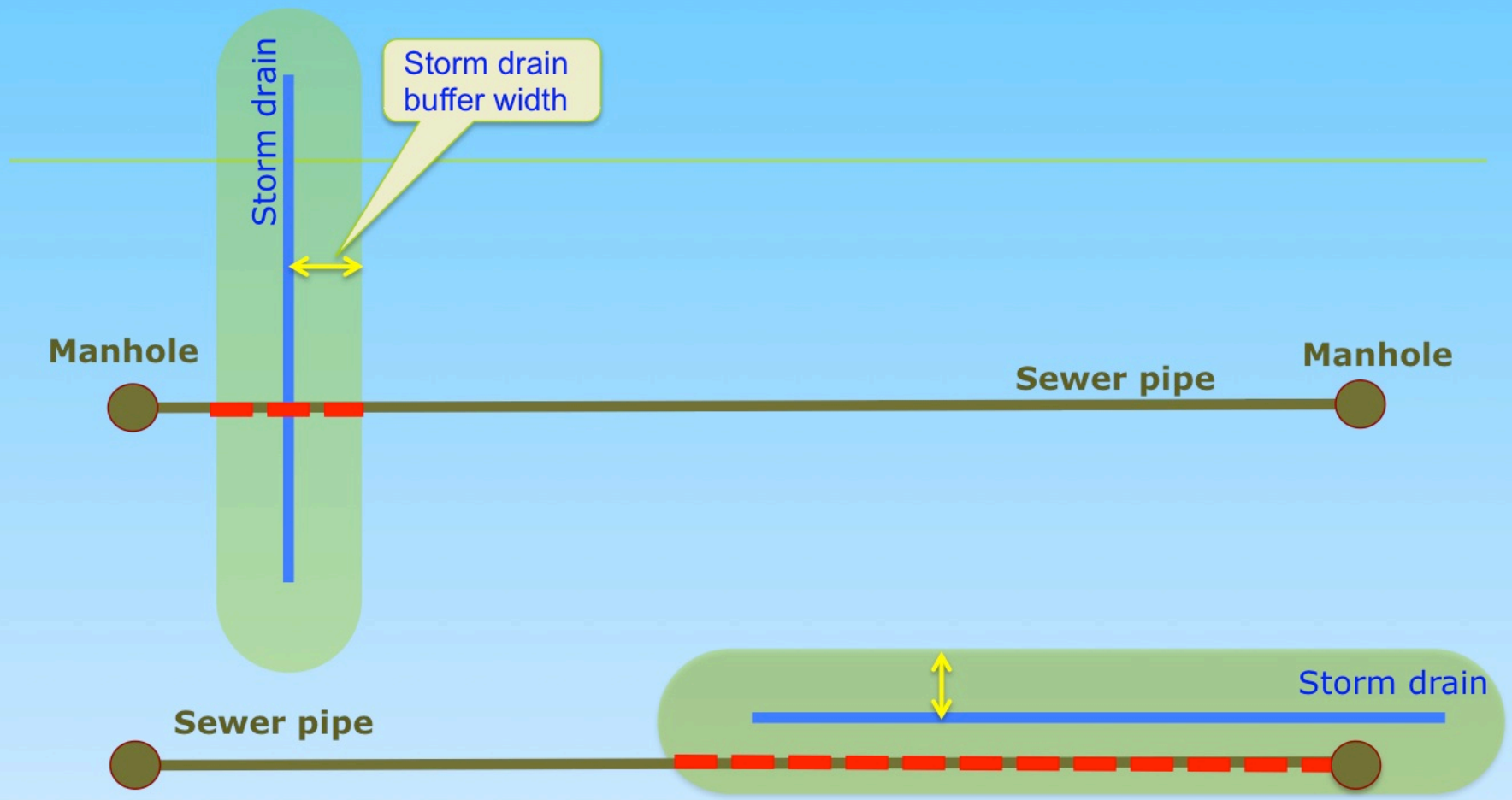
2. Score pipes* according to their degree of intersection with a buffer

*Sewer mains with Facility IDs: usually sewer pipe sections between adjacent manholes


Storm drain
Storm drain
buffer width
Manhole
Sewer pipe
Manhole
Sewer pipe
Storm drain


Storm drain
Storm drain buffer width
Red-hatched section is a small percent of sewer pipe length. Less Risky
Manhole
Sewer pipe
Manhole
Sewer pipe
Storm drain


Storm drain
Storm drain buffer width
Manhole
Sewer pipe
Manhole
Sewer pipe
Storm drain
Red hatched section is a large percent of total pipe length. More Risky



Buffer widths evaluated: 5-feet, 10-feet, and 20-feet

10-foot and 20-foot buffers retained for scores

Derivation of Scores

Proximity to Storm Drains

Scores represent percent of pipe length within a buffer

0:	0%
1:	0% <x ≤ 20%
2:	20% <x ≤ 40%
3:	40% <x ≤ 60%
4:	60% <x ≤ 80%
5:	80% <x ≤ 100%

Derivation of Scores

Sewage Conductivity

- 59 manholes sampled on 8 days in October 2014
- Conductivity ranged 250-33,550 μS cm^{-1}
- Values converted to "enrichment factors"

[Sewage conductivity]÷[WWTP influent conductivity on same day]

- Scores for manholes assigned to sewer mains whose facility IDs included those manholes

Binning of enrichment factors

0:	≤ influent
1:	0 <x ≤ 2.5
2:	2.5 <x ≤ 5
3:	5 <x ≤ 7.5
4:	7.5 <x ≤ 10
5:	X > 10

Derivation of Scores

Summary

Scores ranging from 0-5 were assigned to sewer pipes for **10 criteria**:

Basis for Risk Assessment			Criterion Code
Physical Pipe Defects (CCTV inspections)	PACP Structural		Pacp_Struc
	PACT Maintenance		Pacp_Maint
	City's alphabetic scores for large pipe defects		LgPipeScor
Proximity to Storm Drains	Any storm drain	10-foot buffer	10ProxScor
		20-foot buffer	20ProxScor
	"Floodable" storm drains	10-foot buffer	F_10PrxScr
		20-foot buffer	F_20PrxScr
	Perforated Storm Drains	10-foot buffer	PD10PrxScr
		20-foot buffer	PD20PrxScr
Sewage Conductivity			ConducScr

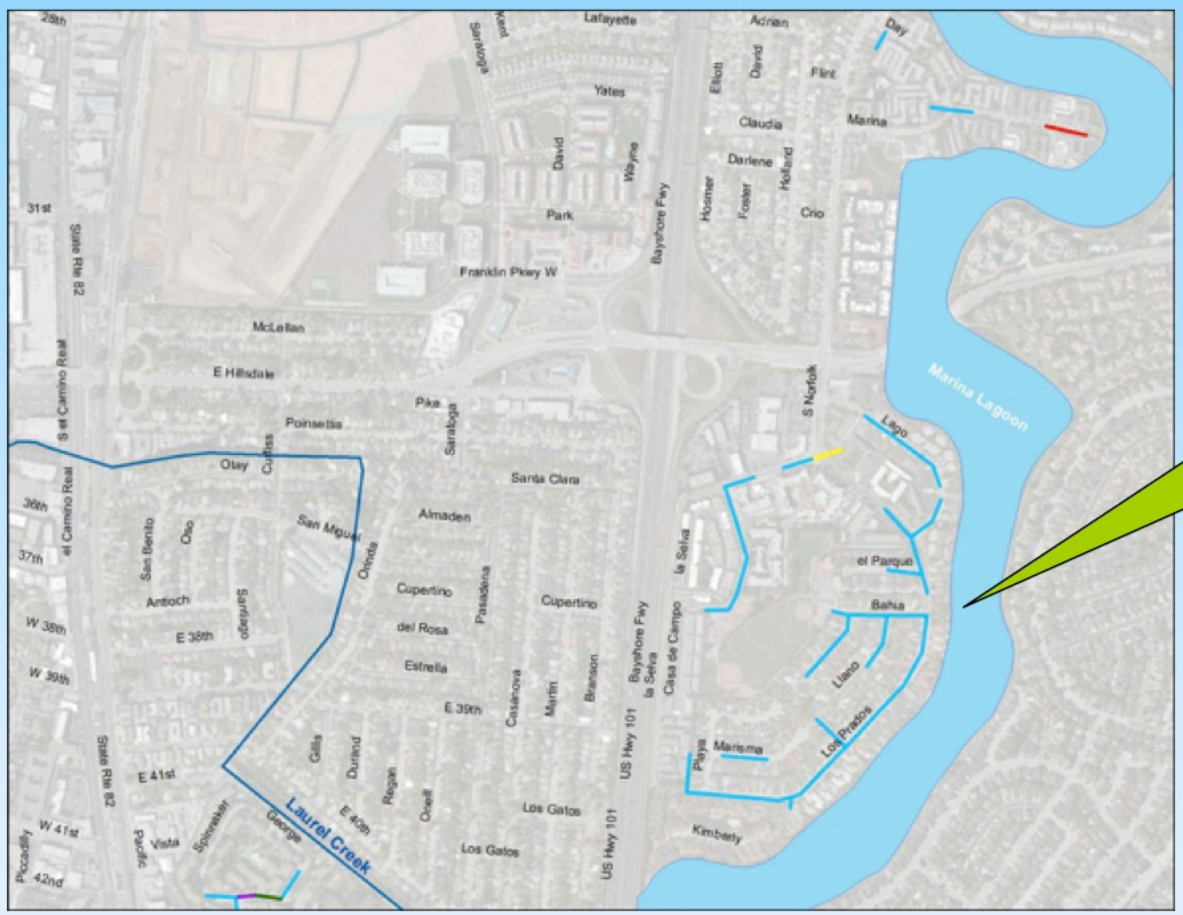
Posters show scores for some of these criteria

“Querying the Tool”

- The “tool” is a shapefile. Attribute table includes a field for each of the 10 risk criteria containing the 0-5 numeric scores (along with lots of other data)
- The attribute table can be queried to find sewer pipes that meet more than one criterion.
- GIS practioner can perform queries with existing tool, or combine with other geodatabases (e.g., SSOs)

“Querying the Tool”

“What are the ***structural*** defect scores for pipes within 20 feet of a ***perforated*** storm drain?”



Most sewer pipes that come within 20 feet of a perforated storm drain have PACP structural defect scores = 0 (No Risk, blue)

“Querying the Tool”

“What are the ***maintenance*** defect scores for pipes within 20 feet of a ***perforated*** storm drain?”

Some sewer pipes that come within 20 feet of a perforated storm drain have serious PACP ***maintenance*** defect scores

Caveats

- Owing to limitations in available data, the scores do not distinguish between risk of **infiltration** versus **exfiltration.** However, **both processes are pertinent** to potential contamination of receiving waters:
  - Infiltration can lead to capacity issues and SSOs
  - Exfiltration can directly contaminate storm drains in absence of SSOs
- Storm drain condition not part of the analysis
- Vertical proximity of storm drains and sewer mains unknown – not available in electronic form

Caveats

- PACP scores reflect grade of worst defect(s), but not number of defects
- Force mains vs gravity mains would affect potential for exfiltration

Acknowledgements

Huge Thanks to

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Thank you!