



STORM DRAIN MASTER PLAN



Carmel-by-the-Sea Storm Drain Master Plan



Storm Drain Master Plan & Climate Change

Climate Committee Meeting
December 17, 2020



Purpose of a Storm Drain Master Plan

- Guides planning, design, construction, operation, and maintenance of storm drainage infrastructure
- Develops a model of existing storm drain system to:
 - Assess the physical condition of the system
 - Identify bottlenecks/capacity limitations
 - Prioritize required improvements
- Assesses impacts due to changing environmental conditions and future development

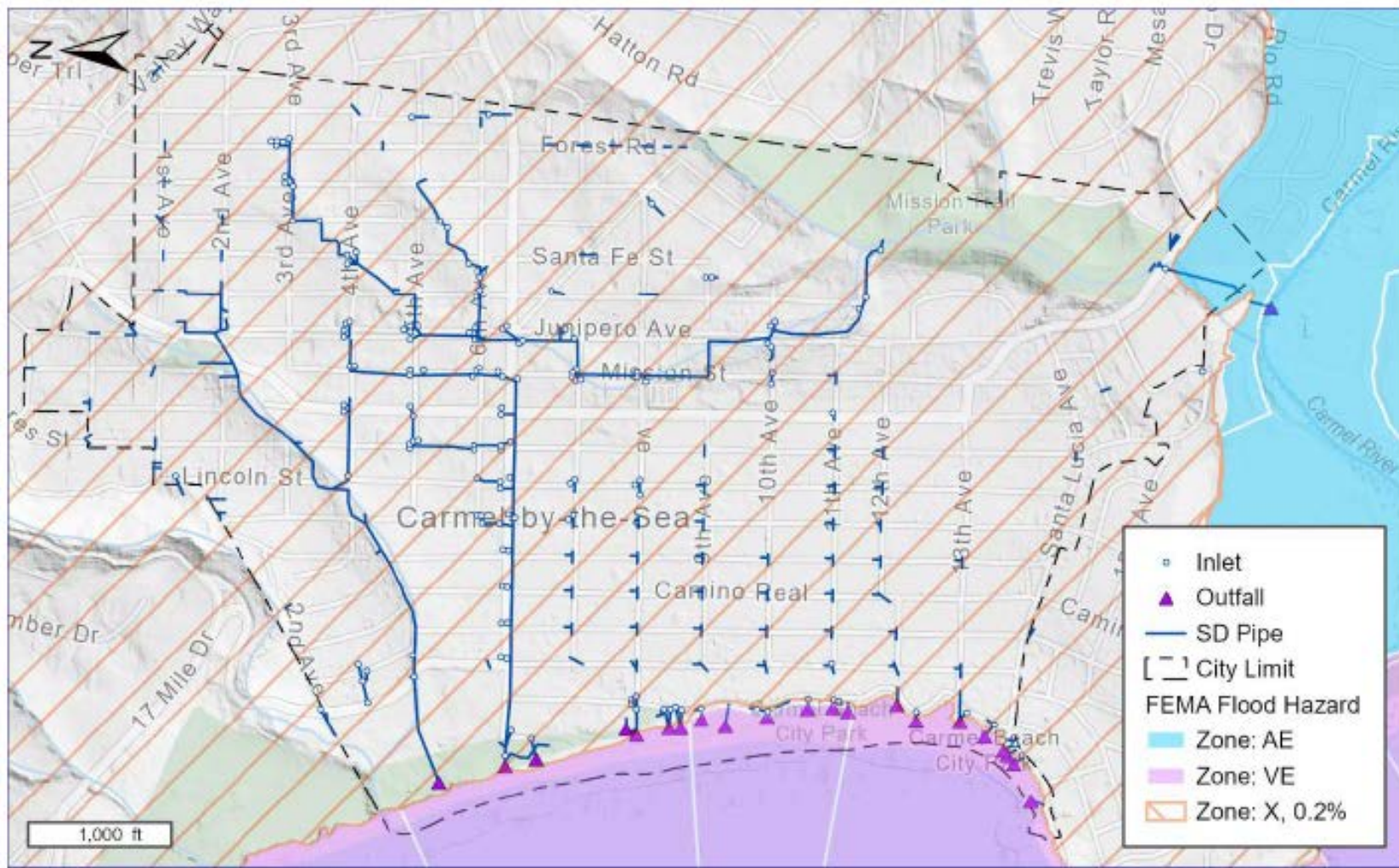


Concerns prior to SDMP

Concerns	Potential Impacts
No prior Master Plan (104 Years)	Hodgepodge development of system? Whack-a-Mole flooding.
Capacity of system unknown	Emergency preparedness and response
Unknown physical condition of system (CCTV)	Failures, sink holes, flooding due to blockages, water quality
Lack of easements for drainage maintenance	Water flows in channels across private property, potential liability
Stream stability at MTNP	Significant erosion in an environmentally-sensitive habitat
Underground “streams” (filled in canyons w/o pipes)	Basement flooding (i.e. Park Branch Library)
Cost of repairs unknown	Budget for capital improvement projects long term
Climate Change impacts	Stronger storms, sea level rise, increased flooding

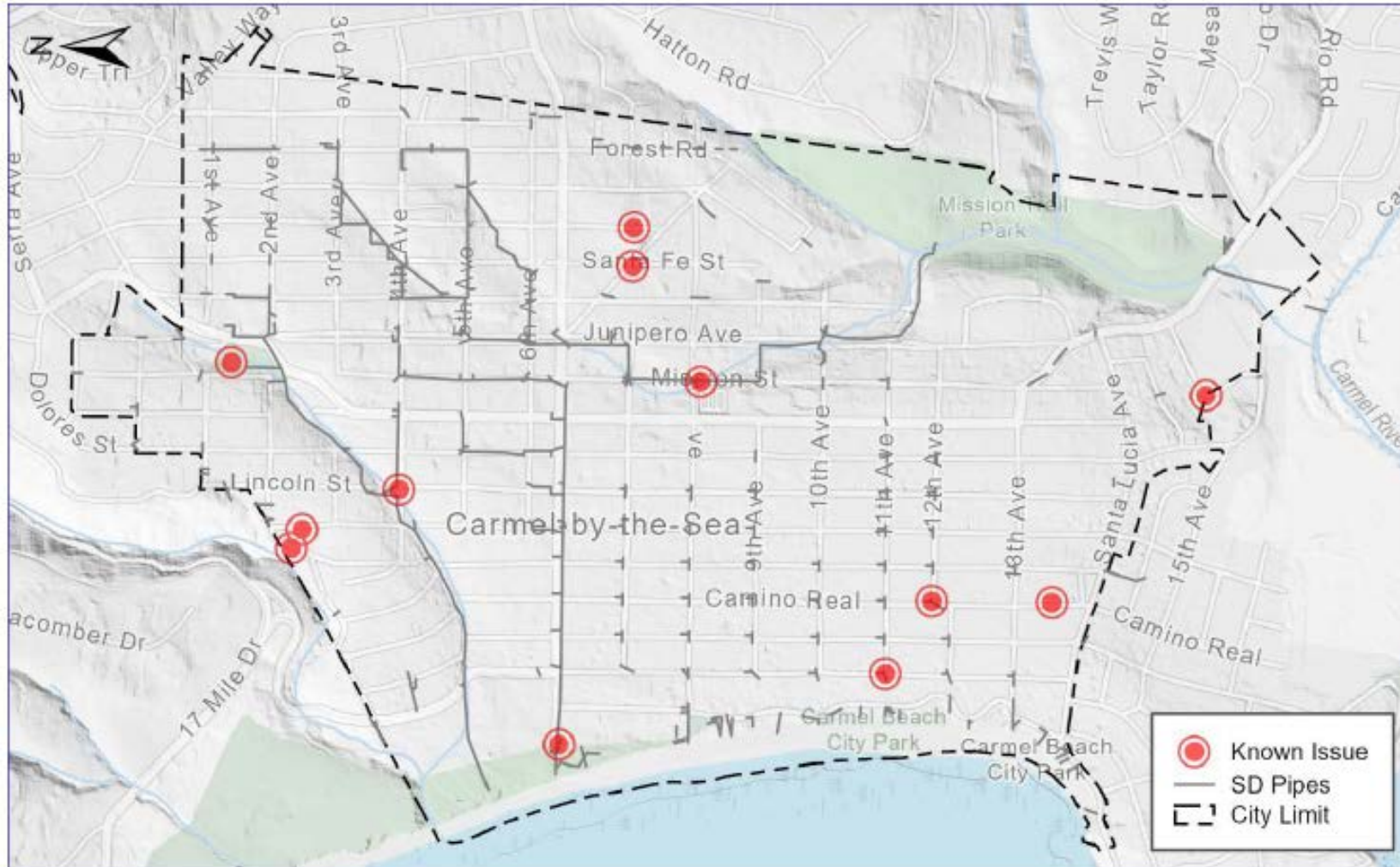


Existing Drainage System





Nuisance Drainage Concerns



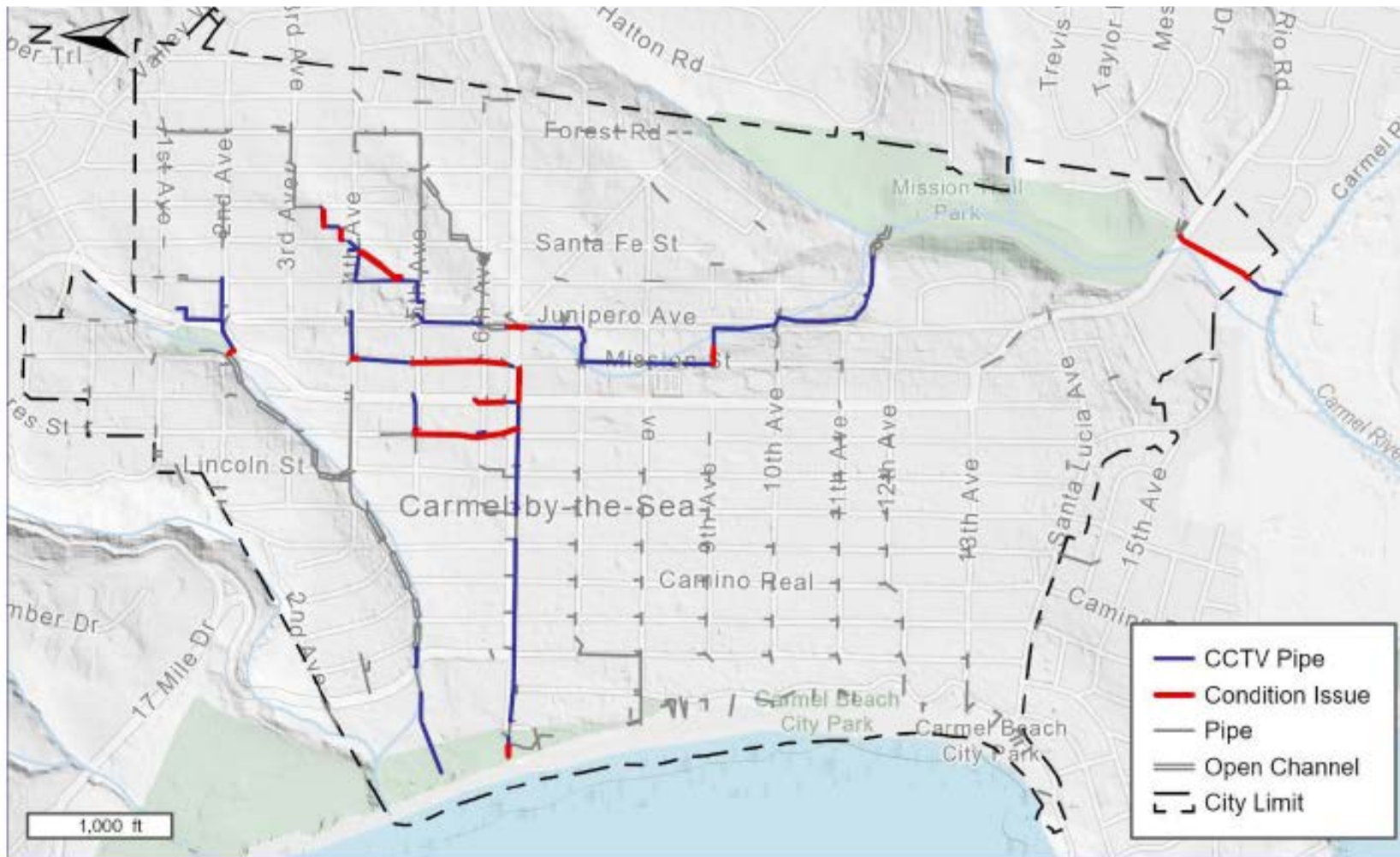


Physical Deficiencies per Survey

Pipes and Box Culverts	Manholes, Catch Basins, and Open Channels	Drainage Outlets
<p>271 Pipe segments = 6.5 Miles</p>	<p>264 Manholes and Catch Basins</p>	<p>22 Outlets: 20 to Carmel Bay Double Box, MTNP/Rio to River</p>
<ul style="list-style-type: none"> • Cracked pipes 	<ul style="list-style-type: none"> • Sediment (Rio Road) 	<ul style="list-style-type: none"> • 4 Undersized Hydrodynamic Separator Units –Trash & Sediment Capture/Water quality
<ul style="list-style-type: none"> • Broken liners 	<ul style="list-style-type: none"> • Debris in catch basins 	<ul style="list-style-type: none"> • Cleaning of units
<ul style="list-style-type: none"> • Offset joints 	<ul style="list-style-type: none"> • Deep manholes (confined spaces) 	<ul style="list-style-type: none"> • Beach erosion/ public safety concerns
<ul style="list-style-type: none"> • Sags and sediment 	<ul style="list-style-type: none"> • Open channels – erosion, maintenance (vegetation) 	<ul style="list-style-type: none"> • Minor contributing factor to undermining sea walls along the bluff
<ul style="list-style-type: none"> • Collapse 	<ul style="list-style-type: none"> • Open channels – pedestrian and parking safety 	



Physical Deficiencies





Pipe Cracking, Collapse





Pipe Sag, Debris in Catch Basin





Pipe Joint Problems





Misc. Defects and Deposits

MH-027 TO DI-076
11/12/2019 DOLORES ST 10:27

Obstacle Intrudin
48.4 FT

REBAR
OFPM

MH-018 TO MH-018-A
11/11/2019 MISSION ST 14:58

Deposits Settled
3 FT

SAND/GRAVEL
OFPM

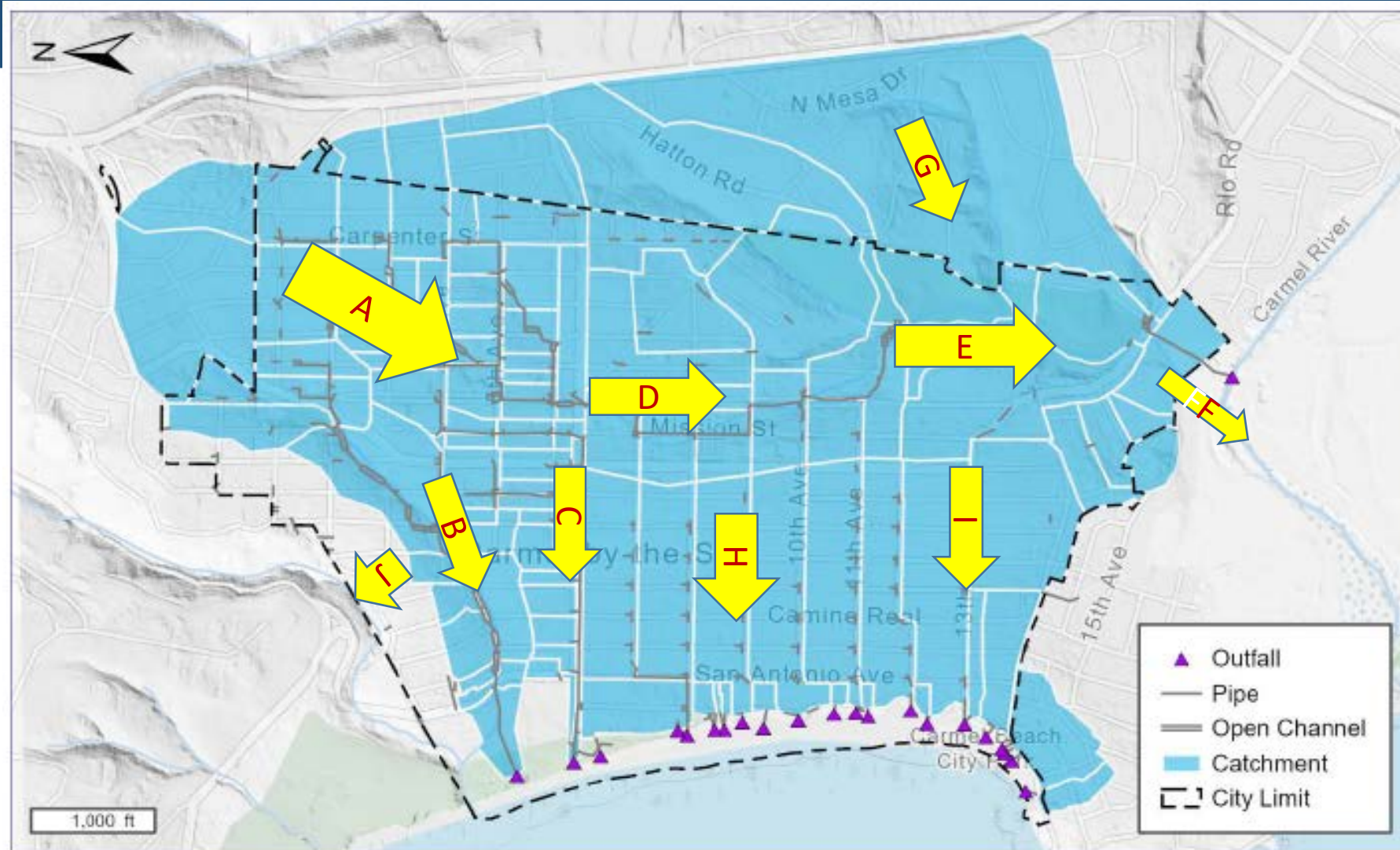


Hydrology Model – Surface Runoff

- ✓ Storm intensity – Our model was per NOAA, 10-yr, 3-inches in 24 hours
- ✓ *(Most cities design their storm drains for 20-year storms)*
- ✓ 10-year storm in 2045 is 3.48 inches in 24 hours
- ✓ 50-year storm in 2045 is 5.04 inches in 24 hours
- ✓ 105 Drainage catchment areas (from peaks beyond city limits)
- ✓ Topography
- ✓ Land use (paved vs. soil)
- ✓ Soil classifications (gravel, sand, clay)
- ✓ Lag time
- ✓ GIS data
- ✓ National Resource Conservation Service Hydrology Method
- ✓ Software by Danish Hydraulic Institute
- ✓ 3 Outfalls: Carmel Bay (ASBS), Carmel River, and Pescadero Canyon



Drainage Pattern - Hydrology



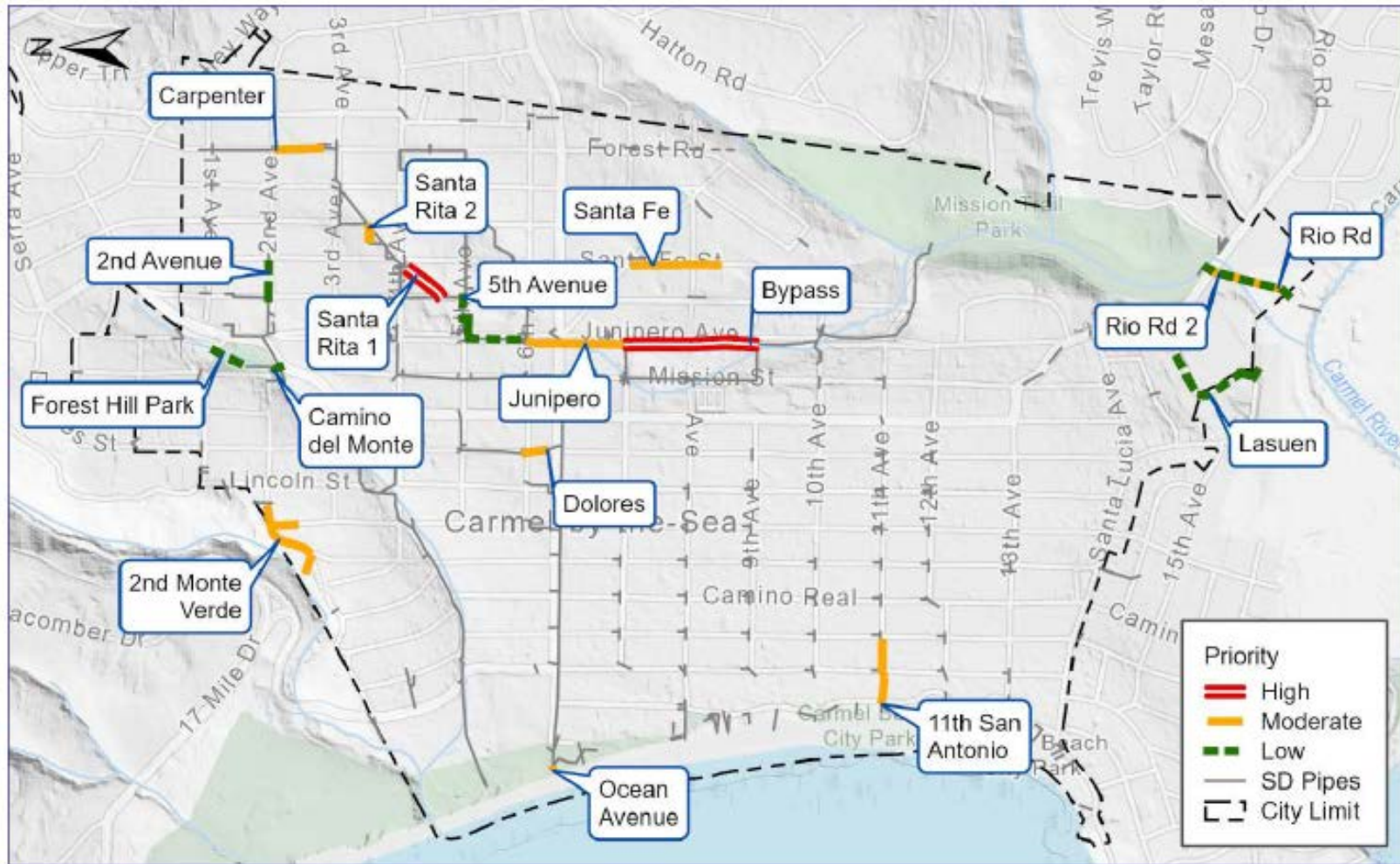


Hydraulic Model – Pipe Flows

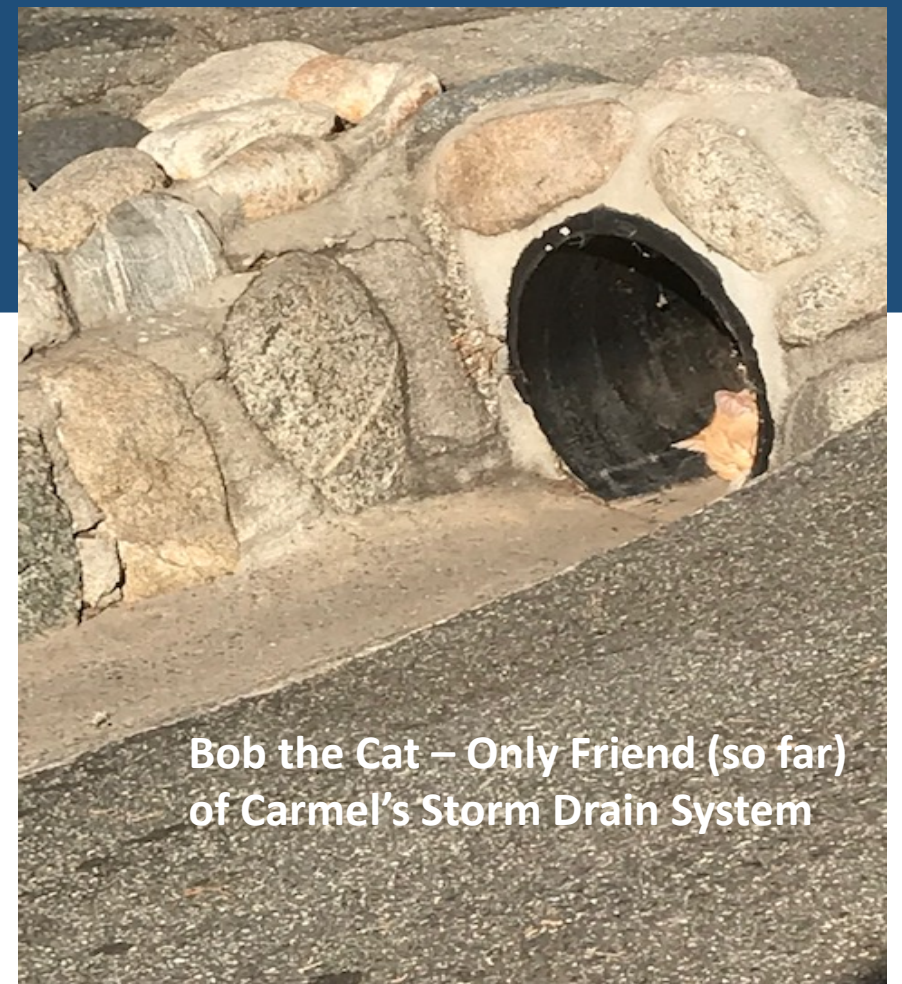
- ✓ Pipe sizes
- ✓ Types of pipe (friction)
- ✓ Pipe slopes
- ✓ Invert elevations
- ✓ Pipe network
- ✓ Culverts
- ✓ Open channels



Projects to Accommodate 10-year Storm



Priority	Asset Name	Estimated Cost ¹
High Priority ★	Mission Street Bypass	\$820,000
	Forest Hill Park – Emergency Repair	\$130,000
	Santa Rita 1	\$220,000
High Priority Total		\$1,170,000
Medium Priority ★★	Junipero	\$800,000
	Rio Road 1	\$2,420,000
	Santa Rita 2	\$170,000
	Ocean Ave	\$250,000
	Santa Fe	\$490,000
	Carpenter	\$270,000
	11 th and San Antonio	\$400,000
	2 nd and Monte Verde	\$830,000
	Forest Hills Park - Realignment	\$700,000
Medium Priority Total		\$6,330,000
Low Priority	2 nd Avenue	\$150,000
	5th and Junipero	\$660,000
	Mission Trail Preserve Projects	\$940,000
	Camino del Monte	\$30,000
	Dolores	\$20,000
	Rio Road 2	\$140,000
	Lasuen	\$460,000
Low Priority Total		\$2,400,000
Grand Total		\$9,900,000



Bob the Cat – Only Friend (so far) of Carmel's Storm Drain System

A \$9.9M investment would allow a 10-year storm event (3-inches) to pass Carmel without flooding



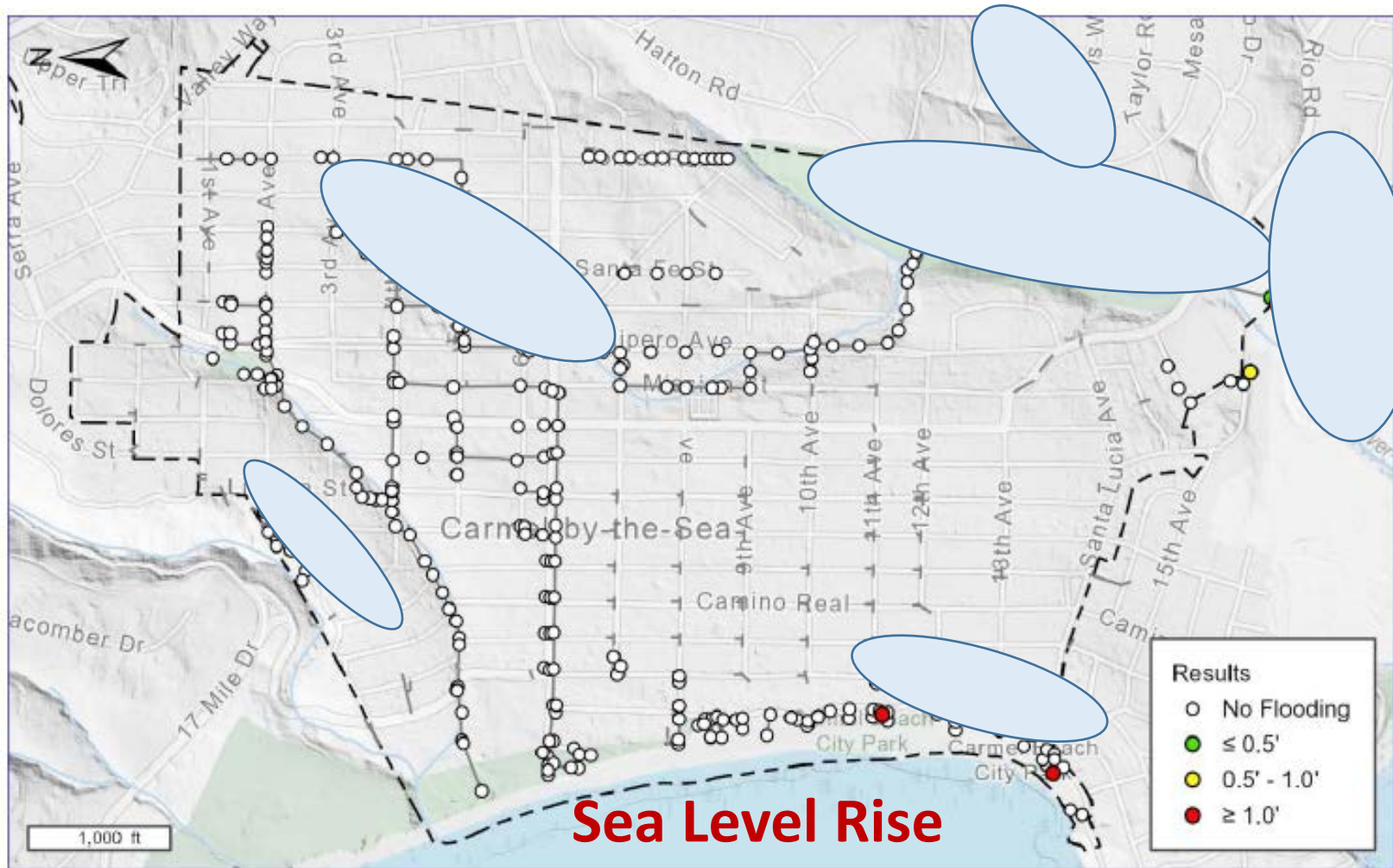
Climate Change – 10-Year Storm, 2045



- With improvements
- Report used 16% storm intensity increase for 2045-2075 from SWMM-CAT model developed by US EPA.
- 3.48 inches in 24 hours
- Predictions have relatively high degree of uncertainty but are helpful in identifying potential future issue areas.



Climate Change – 50-Year Storm, 2045



- With improvements
- For a 50 year storm, the increase range is 12-20%, and the median is 17%
- 5.04 inches in 24 hours
- Flooding is caused by bottlenecks, blockages, and undersized pipes and open channels.



Conclusions

- **Storm Drain Master Plan eliminates “Fear of the Unknown!”**
- **Storm drains were designed piecemeal over time (common) vs. a master planned network**
- **Storm system designed for only 10-year storm events, less costly vs. 20+ years (common)**
- **W/O repairs, a 10-year storm today would cause minor flooding in a few areas**
- **\$9.9M needed to repair the drainage system to handle 10-year storm today**
- **Due to climate change, storms expected to be up to 17% stronger by 2045**
- **Without repairs, a 50-year storm today would cause moderate to significant flooding and damage especially in NE/Downtown and MTNP/Rio/Carmel River**
- **SDMP available on City Website: ci.carmel.ca.us/public-works**

Questions?