

DRAINAGE AND BASEMENT FLOODING 2011

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MAJOR RAIN EVENTS

| RAIN EVENT | TOTAL RAIN (IN) | 60 MIN INTENSITY (IN/HR) | 5 MIN INTENSITY (IN/HR) | SANITARY PEAK FLOW RATE-WWTP (MGD) |
|-------------------|----------------------------|---|--|---|
| 2/28/2011 | 2.09* | 0.67 | 2.28 | 170 |
| 4/4/2011 | 1.3 | 0.6 | 0.27 | 101 |
| 4/25/2011 | 1.65 | 0.58 | 2.16 | 151 |
| 5/25/2011 | 1.69 | 1.49 | 7.8 | 139 |

HISTORICAL RAIN EVENTS

- 7 OUT 11 IN LAST 20 YEARS
- 2-28-11 RAIN EVENT
 - 25-50 YEAR STORM EVENT
 - 100 YEAR FLOOD EVENT

TOP 11 RAIN EVENTS IN 100 YEARS

| RANK | DATE | RAIN |
|------|------------|-------|
| 1 | 9/7/1996 | 4.59 |
| 2 | 8/20/2005 | 3.55 |
| 3 | 8/13/1994 | 3.55 |
| 4 | 5/24/1955 | 3.36 |
| 5 | 10/15/1954 | 3.36 |
| 6 | 7/27/1928 | 3.38 |
| 7 | 9/12/1938 | 3.34 |
| 8 | 8/7/2007 | 3.33 |
| 9 | 2/28/2011 | 2.28* |
| 10 | 2/6/2008 | 2.5* |
| 11 | 5/25/2011 | 7.8* |

*SIGNIFICANT SNOW MELT

5 min duration

Rainfall (inches) for given recurrence interval

| Duration | 2-month | 3-month | 4-month | 6-month | 9-month | 1-year | 2-year | 5-year | 10-year | 25-year | 50-year | 100-year |
|----------|---------|---------|---------|---------|---------|--------|--------|--------|---------|---------|---------|----------|
| 10-day | 1.70 | 2.05 | 2.36 | 2.78 | 3.19 | 3.47 | 4.29 | 5.34 | 6.17 | 7.30 | 8.19 | 9.14 |
| 5-day | 1.37 | 1.64 | 1.86 | 2.15 | 2.47 | 2.69 | 3.34 | 4.23 | 4.95 | 5.96 | 6.82 | 7.74 |
| 72-hr | 1.26 | 1.48 | 1.67 | 1.94 | 2.23 | 2.42 | 2.99 | 3.72 | 4.34 | 5.31 | 6.15 | 7.09 |
| 48-hr | 1.18 | 1.38 | 1.53 | 1.78 | 2.04 | 2.22 | 2.75 | 3.42 | 3.99 | 4.87 | 5.66 | 6.55 |
| 24-hr | 1.12 | 1.31 | 1.43 | 1.65 | 1.88 | 2.04 | 2.50 | 3.10 | 3.60 | 4.39 | 5.11 | 5.89 |
| 18-hr | 1.06 | 1.23 | 1.34 | 1.56 | 1.77 | 1.92 | 2.35 | 2.91 | 3.38 | 4.13 | 4.80 | 5.54 |
| 12-hr | 0.97 | 1.13 | 1.24 | 1.43 | 1.63 | 1.77 | 2.17 | 2.70 | 3.13 | 3.82 | 4.45 | 5.12 |
| 6-hr | 0.84 | 0.98 | 1.07 | 1.24 | 1.41 | 1.53 | 1.88 | 2.32 | 2.70 | 3.29 | 3.83 | 4.42 |
| 3-hr | 0.72 | 0.84 | 0.92 | 1.06 | 1.21 | 1.31 | 1.60 | 1.98 | 2.30 | 2.81 | 3.27 | 3.77 |
| 2-hr | 0.65 | 0.76 | 0.83 | 0.96 | 1.09 | 1.18 | 1.45 | 1.80 | 2.09 | 2.55 | 2.96 | 3.42 |
| 1-hr | 0.53 | 0.61 | 0.67 | 0.78 | 0.88 | 0.96 | 1.17 | 1.46 | 1.69 | 2.06 | 2.40 | 2.77 |
| 30-min | 0.41 | 0.48 | 0.52 | 0.61 | 0.69 | 0.75 | 0.93 | 1.15 | 1.33 | 1.62 | 1.89 | 2.18 |
| 15-min | 0.30 | 0.35 | 0.38 | 0.45 | 0.51 | 0.55 | 0.68 | 0.84 | 0.97 | 1.19 | 1.38 | 1.59 |
| 10-min | 0.24 | 0.28 | 0.30 | 0.35 | 0.40 | 0.43 | 0.52 | 0.65 | 0.76 | 0.92 | 1.07 | 1.24 |
| 5-min | 0.13 | 0.15 | 0.17 | 0.19 | 0.22 | 0.24 | 0.30 | 0.37 | 0.43 | 0.53 | 0.61 | 0.71 |

TYPES OF FLOODING

- STREETS
- REAR YARDS
- BASEMENTS
 - STORM WATER
 - SANITARY BACK-UP



STORM SEWER DESIGN

- PRIMARY STREETS
10 YEAR STORM
- SECONDARY STREETS
5 YEAR STORM
- RETENTION BASIN
10 YEAR STORM
- COUNTY CULVERTS
25 YEAR STORM



STREET FLOODING

- OCCURS WHEN THE RAIN EVENT EXCEEDS THE CAPACITY OF THE STORM MAIN
- CURB INLETS ARE FULL OF DEBRIS
 - Leaves
 - Grass
 - Branches
 - Ice



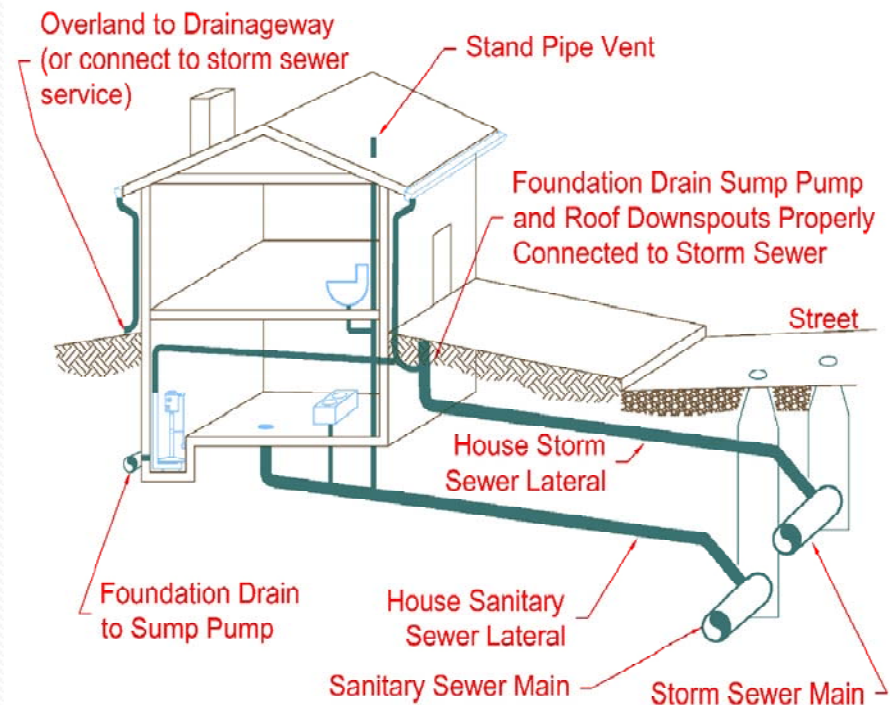
REAR YARD DRAINAGE

- WESTLAKE IS FLAT
- REAR YARD SWALES ARE BLOCKED BY LANDSCAPING
- MANY LOTS ARE SHAPED LIKE A BOWL
- YARD DRAINS REQUIRE MAINTENANCE
- MANY LOTS WERE BUILT WITHOUT DRAINAGE



HOUSE PLUMBING

- STORM SEWER
 - DOWNSPOUTS
 - FOUNDATION DRAIN
 - SUMP PUMP
 - YARD/DRIVEWAY DRAINS
- SANITARY SEWER
 - SHOWERS
 - SINKS
 - TOILETS
 - WASHING MACHINE
- FLOOR DRAINS
 - STORM OR SANITARY

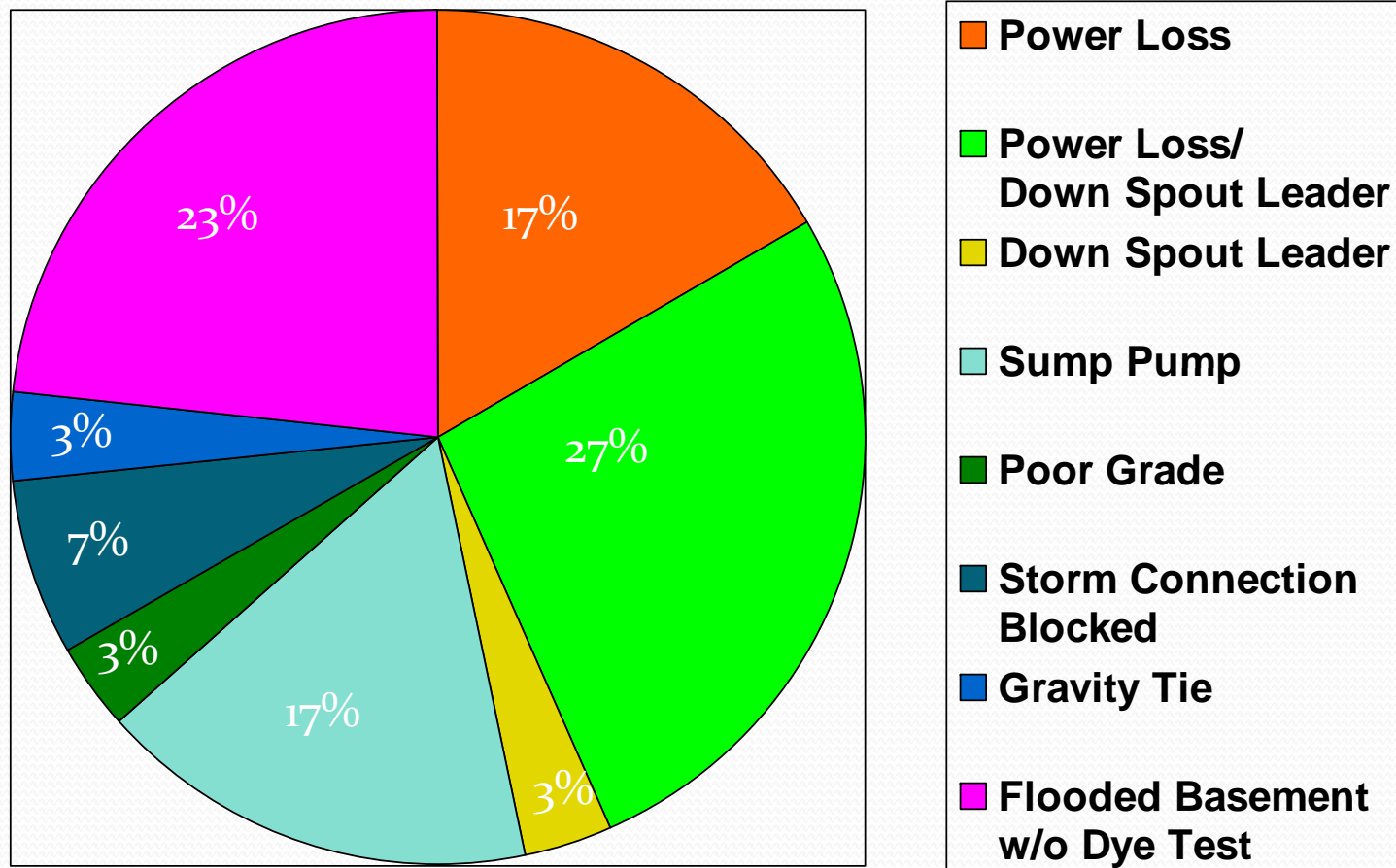


BASEMENT FLOODING

- **STORM WATER INFILTRATION**
 - COMPROMISED FOUNDATION DRAIN
 - SUMP PUMP FAILURE
 - GRAVITY TIE
 - COMPROMISED DOWNSPOUT LEADER
 - POOR GRADE AT FOUNDATION
 - COMPROMISED STORM CONNECTION
- **SANITARY BACK-UP**

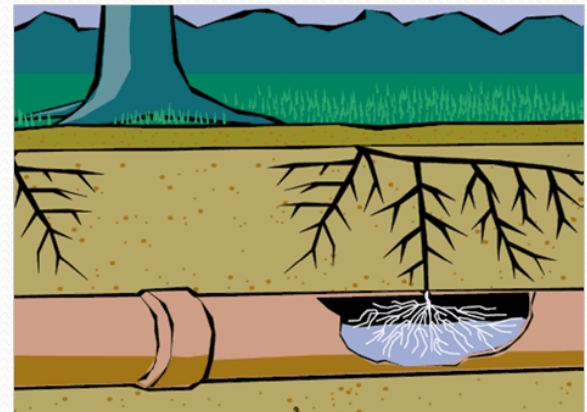


2005 ESTATES BASEMENT FLOOD STUDY



COMPROMISED PLUMBING

- IF THE DOWNSPOUT LEADER IS COMPROMISED WATER IS NOT DRAINED AWAY FROM THE HOUSE AND CONTRIBUTES TO BASEMENT FLOODING





GRAVITY TIE

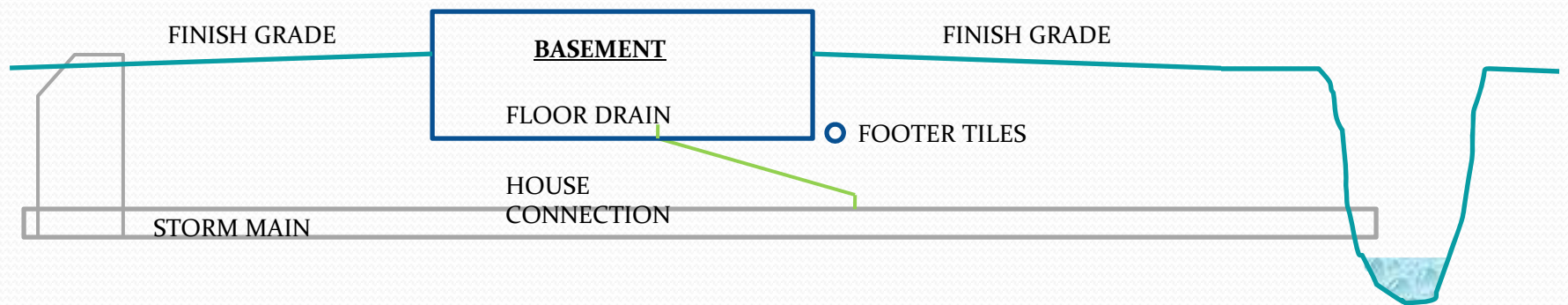
- STORM MAIN IS IN SURCHARGE CONDITION DURING MAJOR RAIN EVENTS
- WATER MIGRATES UP THE STORM CONNECTION
- WATER FLOODS THE BASEMENT
 - FOUNDATION DRAIN
 - FLOOR DRAIN (IF CONNECTED TO STORM)



FLOODING WITH GRAVITY TIE

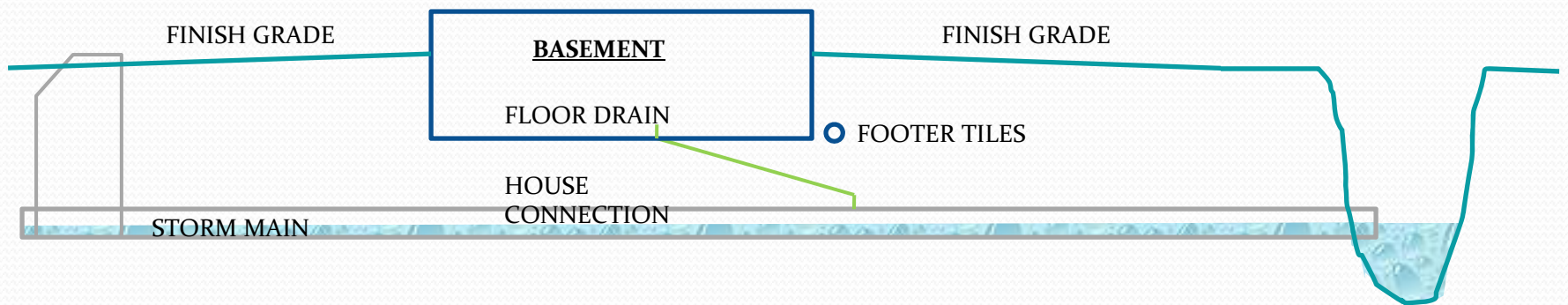
- BRETTON WOODS
- HOLLYWOOD / DUNFORD
- CANTERBURY ROAD
- HILLIARD BLVD.
- WESTHILL / ALLEN
- MELROSE / MAYBELLE
- HORSESHOE
- LOWER DOVER

GRAVITY TIE-BASEMENT FLOODING



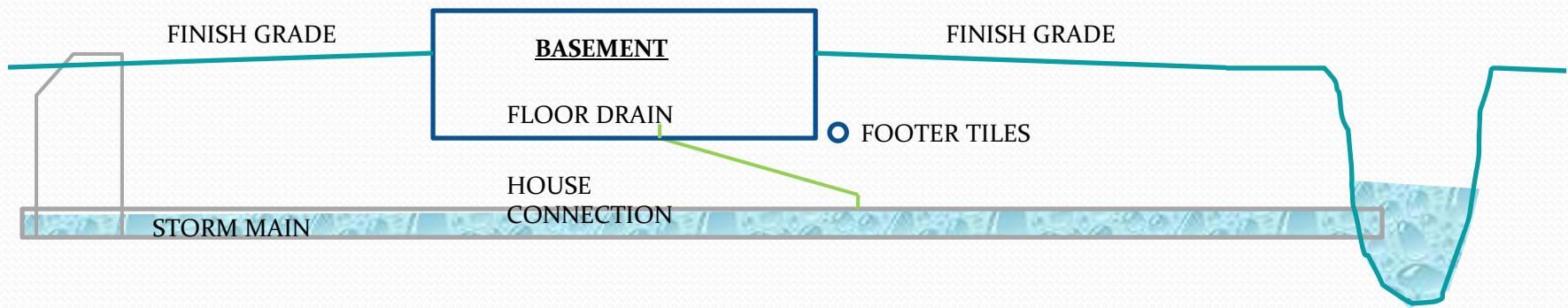
RAIN EVENT CAUSES INCREASE FLOWS
IN DITCH

GRAVITY TIE-BASEMENT FLOODING



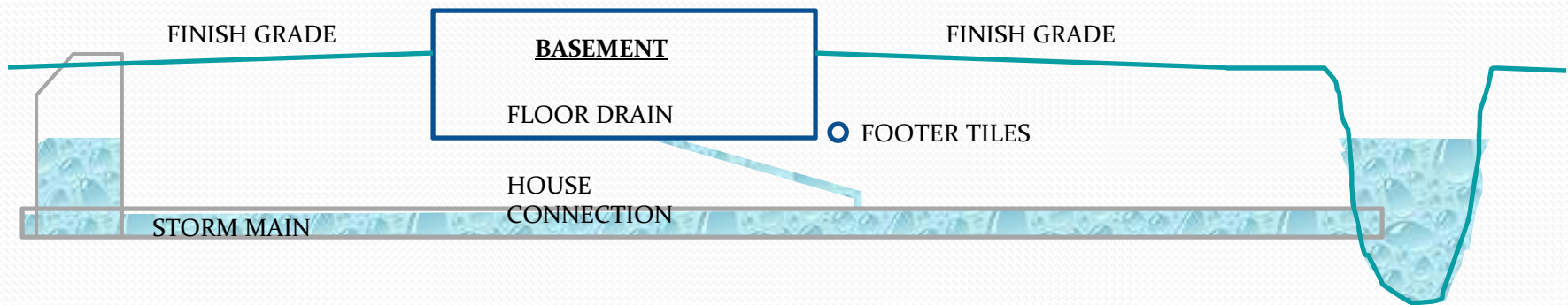
AS RAIN EVENT PROGRESSES DITCH FLOW
INCREASES AND STORM MAIN FLOW
INCREASES

GRAVITY TIE-BASEMENT FLOODING



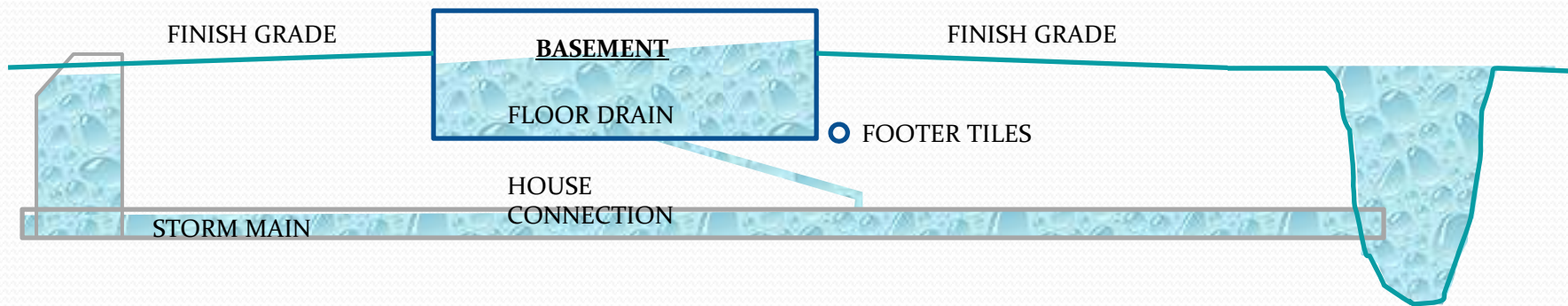
DITCH WATER ELEVATION INCREASES AND
STORM MAIN BECOMES SURCHARGED

GRAVITY TIE-BASEMENT FLOODING



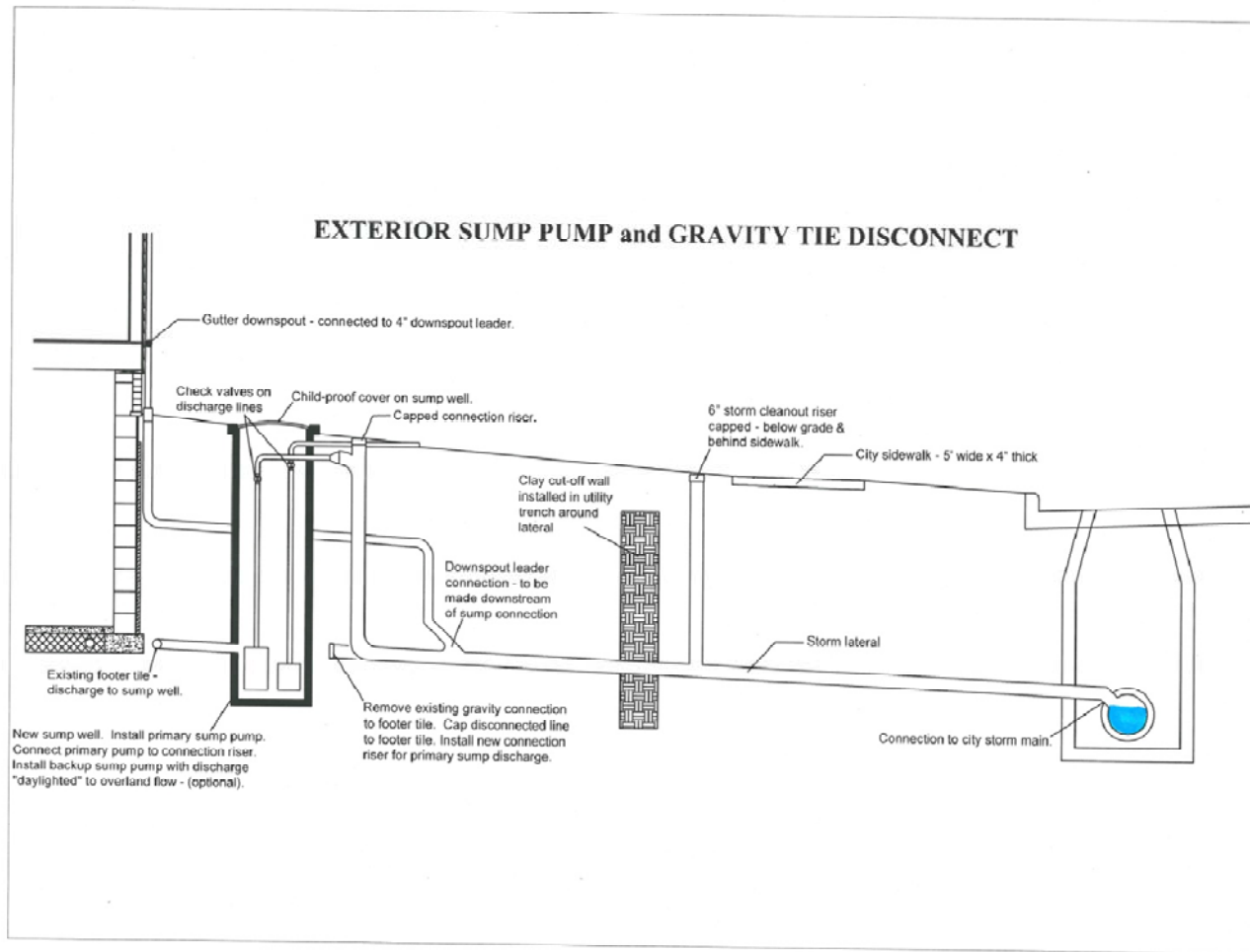
AS STORM MAIN SURCHARGES WATER
MIGRATES UP THE STORM CONNECTION

GRAVITY TIE-BASEMENT FLOODING

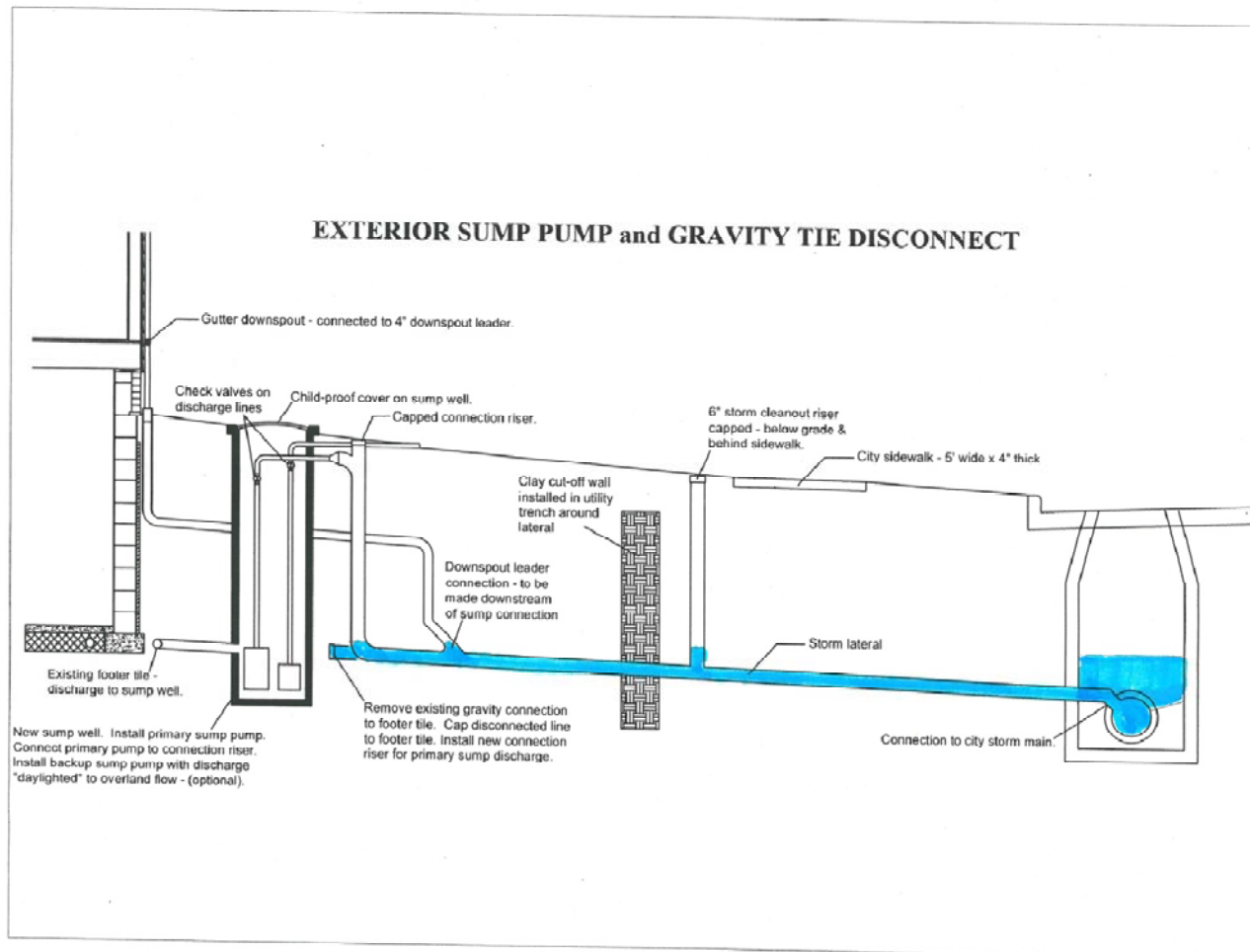


AS DITCH APPROACHES FLOOD STAGE WATER FLOODS THE BASEMENT THRU THE FLOOR DRAIN AND/OR FOUNDATION DRAIN. WATER SEEKS THE FLOOD STAGE ELEVATION

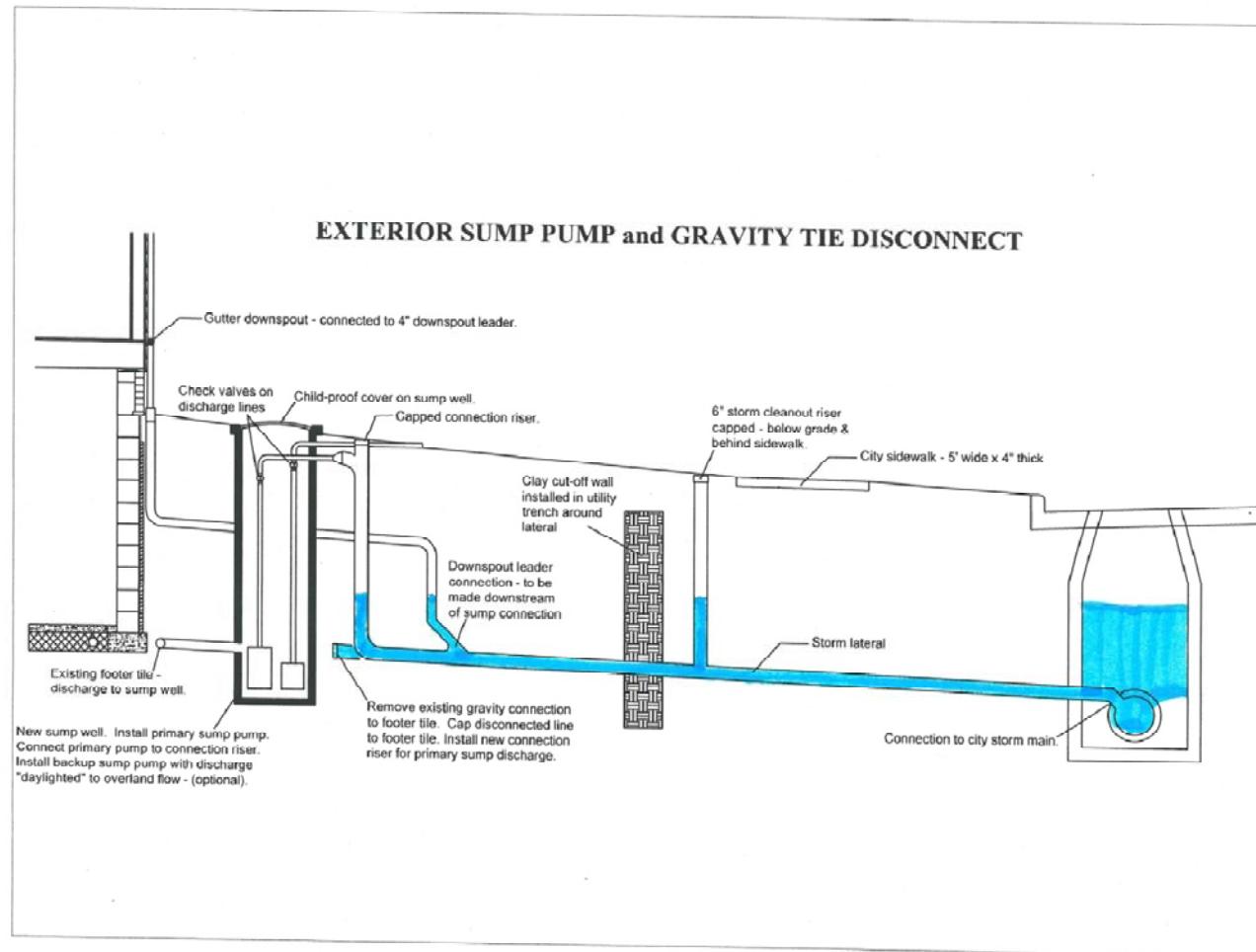
EXTERIOR SUMP PUMP- GRAVITY TIE DISCONNECT



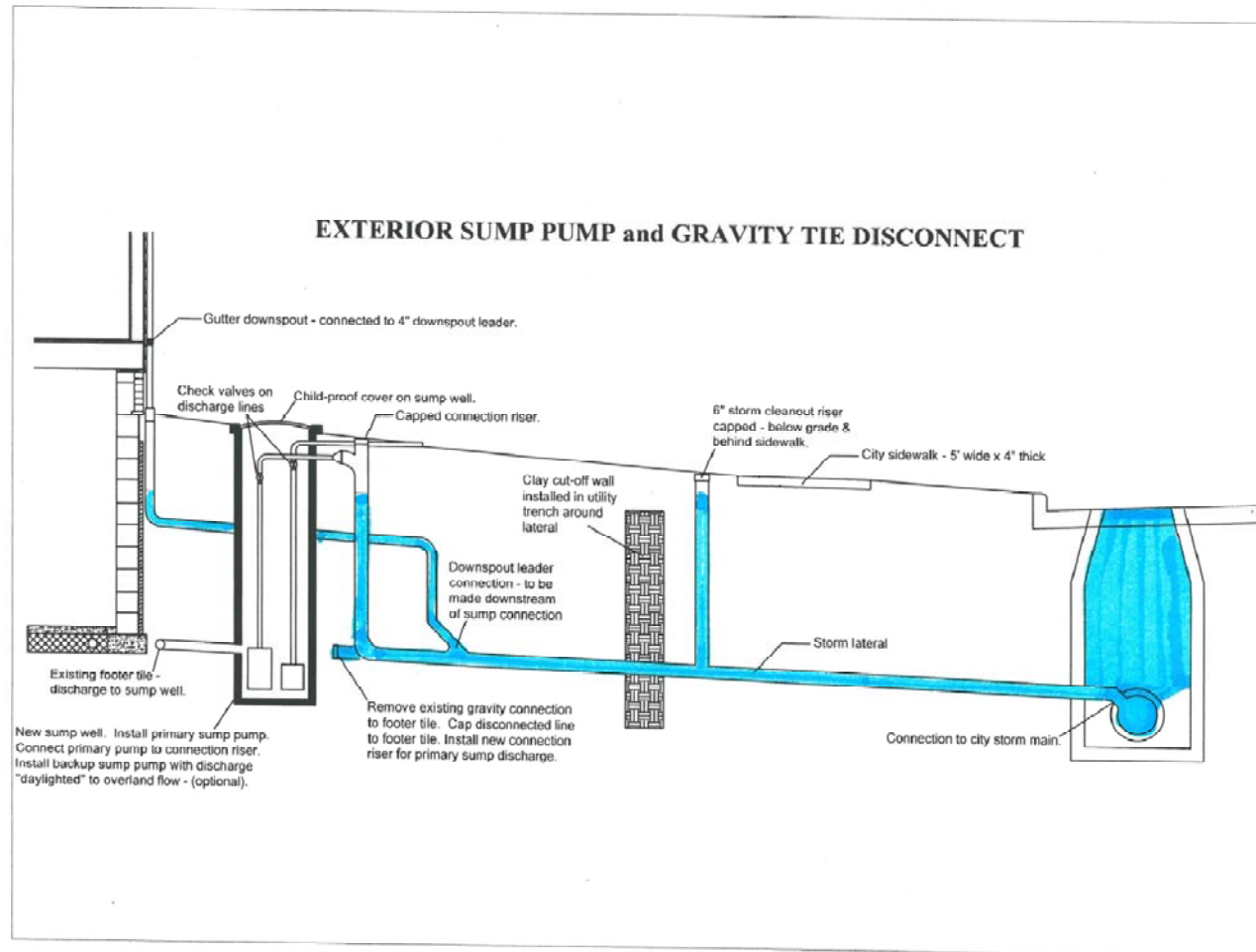
EXTERIOR SUMP PUMP- GRAVITY TIE DISCONNECT



EXTERIOR SUMP PUMP- GRAVITY TIE DISCONNECT

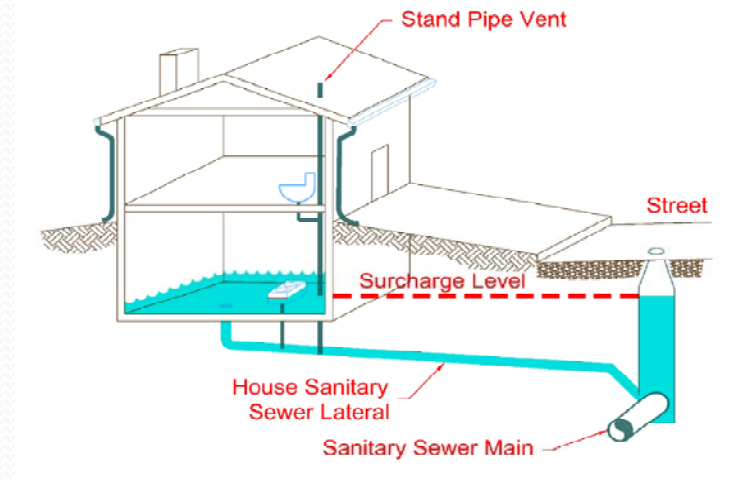


EXTERIOR SUMP PUMP- GRAVITY TIE DISCONNECT



SANITARY SEWER BACK-UP

- RESULTS FROM THE SANITARY SEWER BEING SURCHARGED.
- WATER FROM THE SANITARY SEWER BACKS UP THRU THE CONNECTION AND FLOODS THE BASEMENT:
 - FLOOR DRAINS
 - BASEMENT TOILET
 - BASEMENT SHOWER



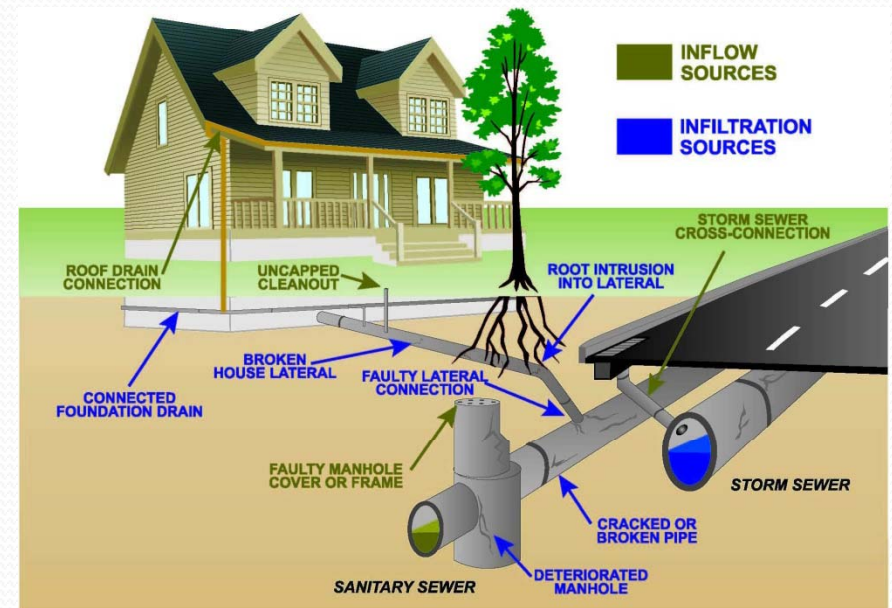
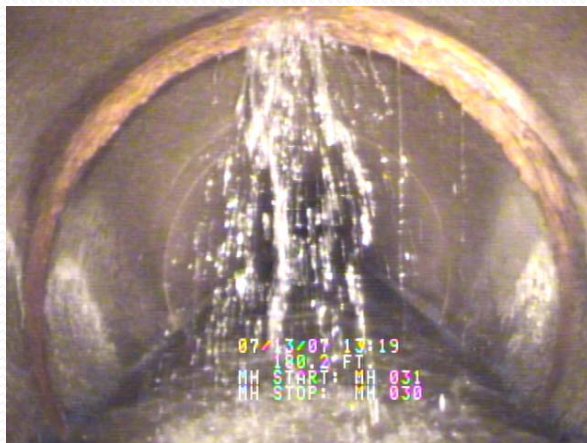
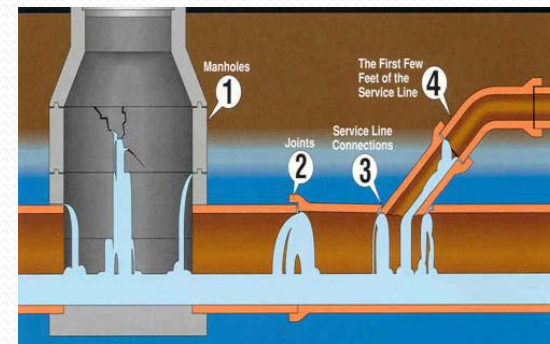


FLOODING WITH SANITARY SEWER BACK-UP

- LOWER DOVER DOVER CENTER
- CEDARWOOD
- BERKELEY ESTATES (ELMWOOD, CHESTNUT ...)
- CANTERBURY ESTATES (SALEM PKWY & RADCLIFF)
- HILLIARD BLVD
 - CANTERBURY / COLUMBIA

SANITARY INFILTRATION & INFLOW

- SOURCES OF STORM WATER IN SANITARY MAIN
 - CROSS-CONNECTIONS
 - INFILTRATION
 - INFLOW
 - MANHOLE VENTS



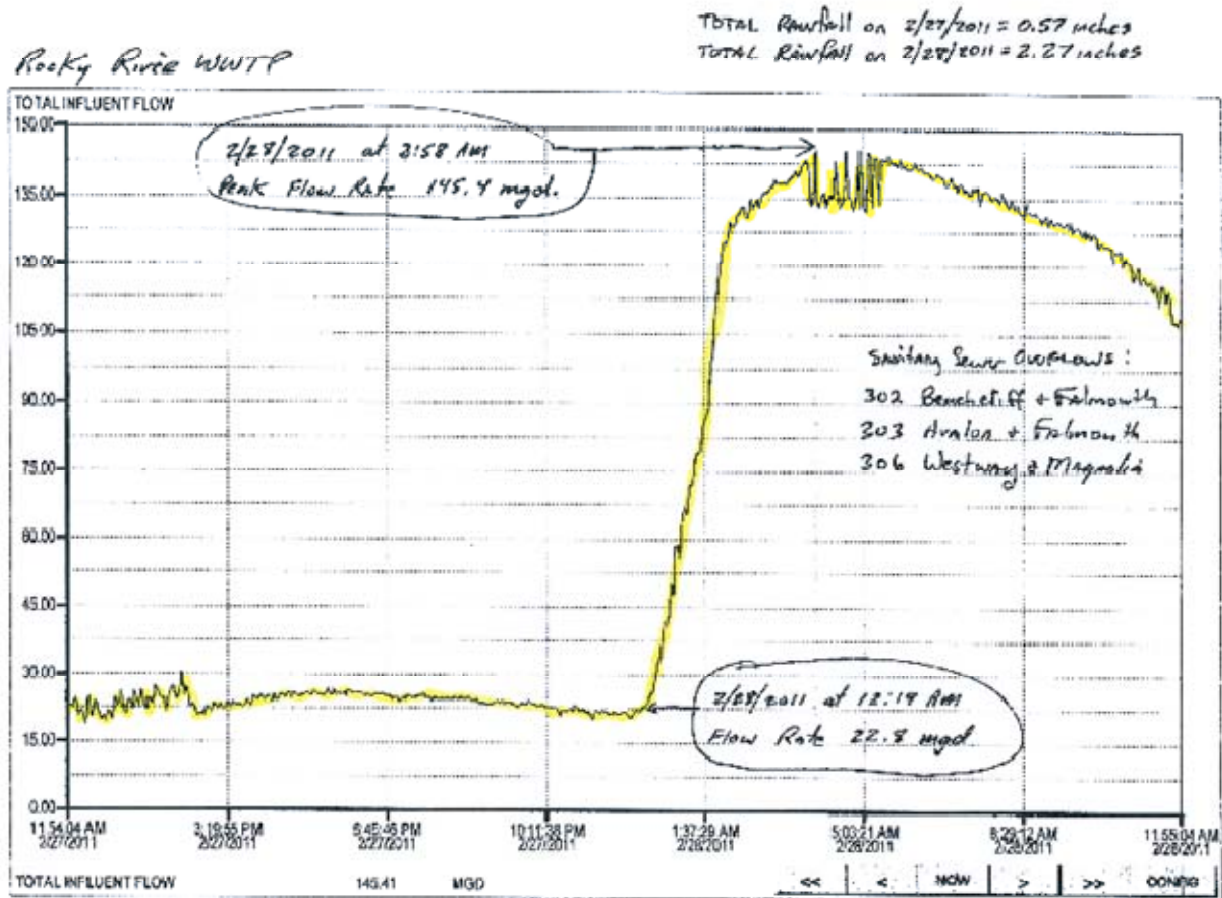
WASTE WATER TREATMENT PLANT

- FOUR CITIES
 - WESTLAKE
 - BAY VILLAGE
 - ROCKY RIVER
 - FAIRVIEW PARK
- AVERAGE FLOW RATE
 - WESTLAKE 5 MGD
 - TOTAL PLANT 13 MGD
- 2-28-11 FLOW RATE
 - TOTAL PLANT 170 MGD
 - RECORD FLOW RATE
 - 82 MILLION GALLONS TREATED IN 24 HOURS

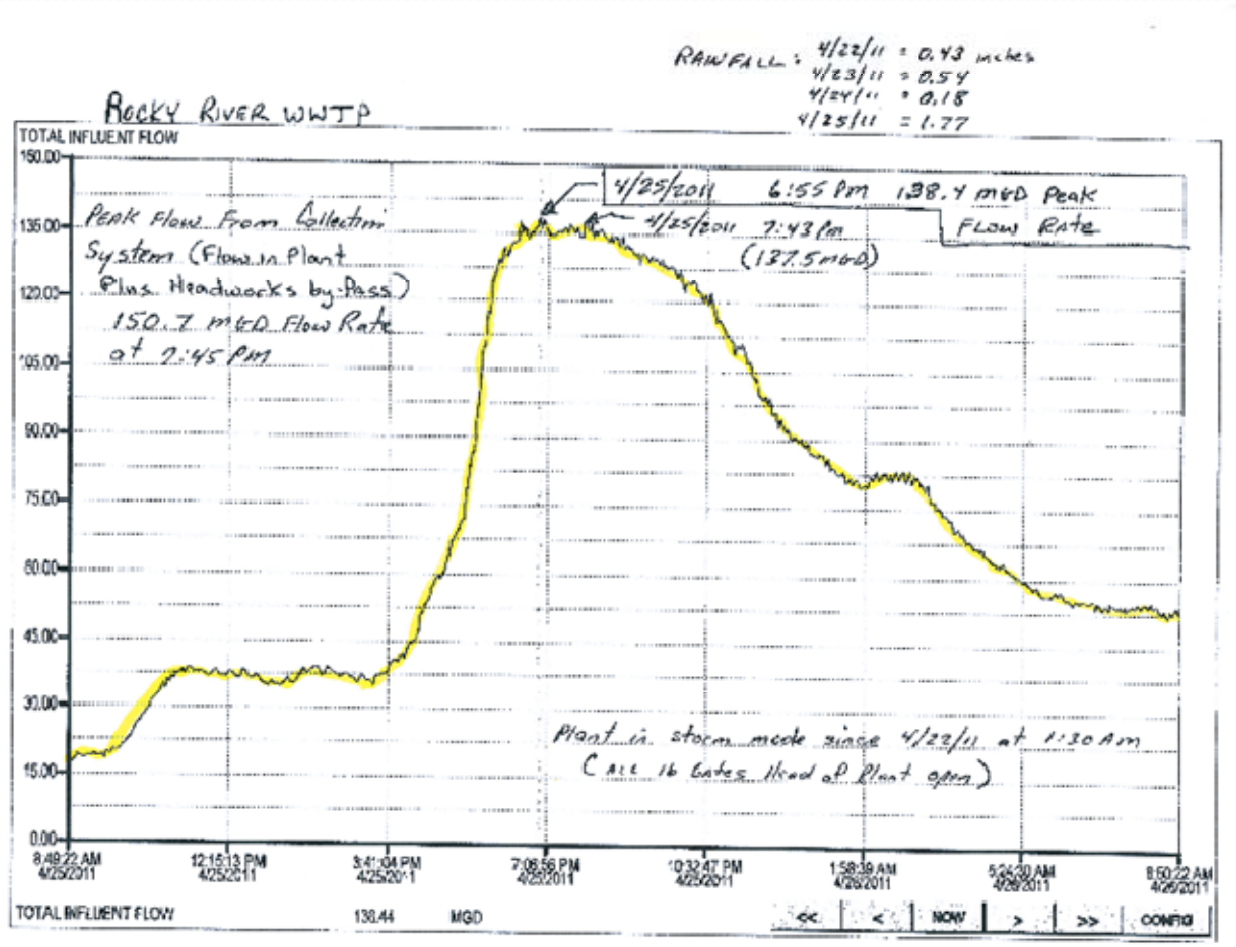


| City | Ratio between Peak WWF & ADWF | Rank |
|---------------|-------------------------------|------|
| Fairview Park | 7.23 | 1 |
| Rocky River | 5.92 | 2 |
| Bay Village | 4.97 | 3 |
| Westlake | 2.99 | 4 |

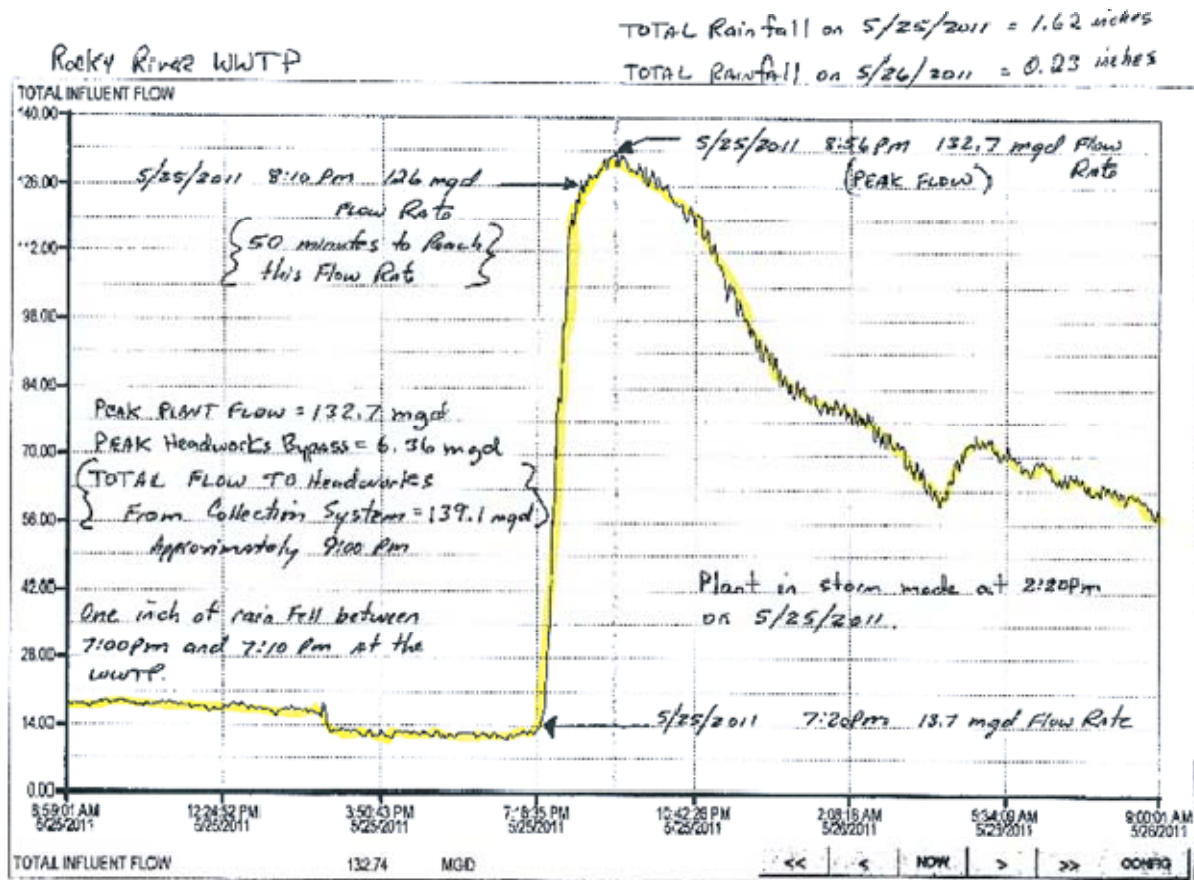
2-28-11 RAIN EVENT



4-25-11 RAIN EVENT

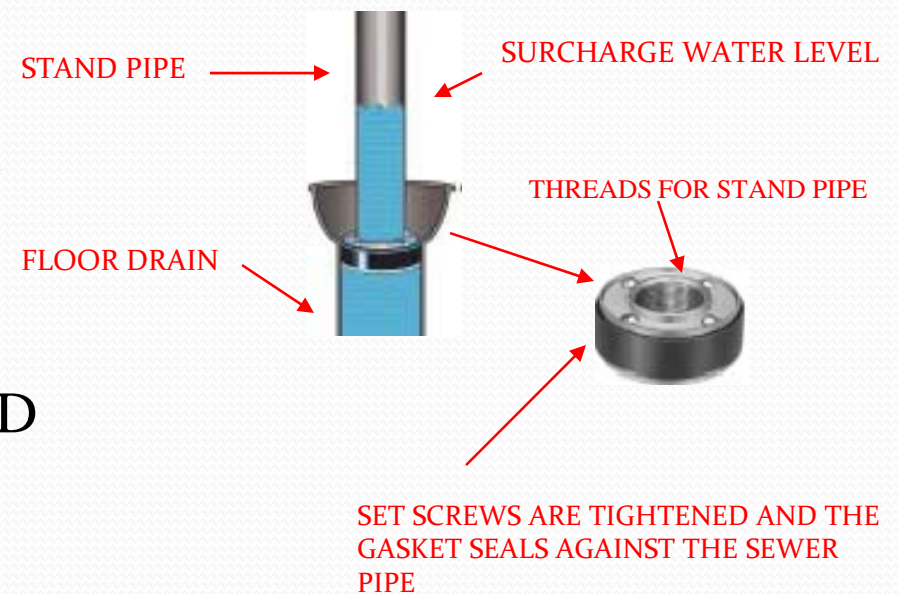


5-25-11 RAIN EVENT



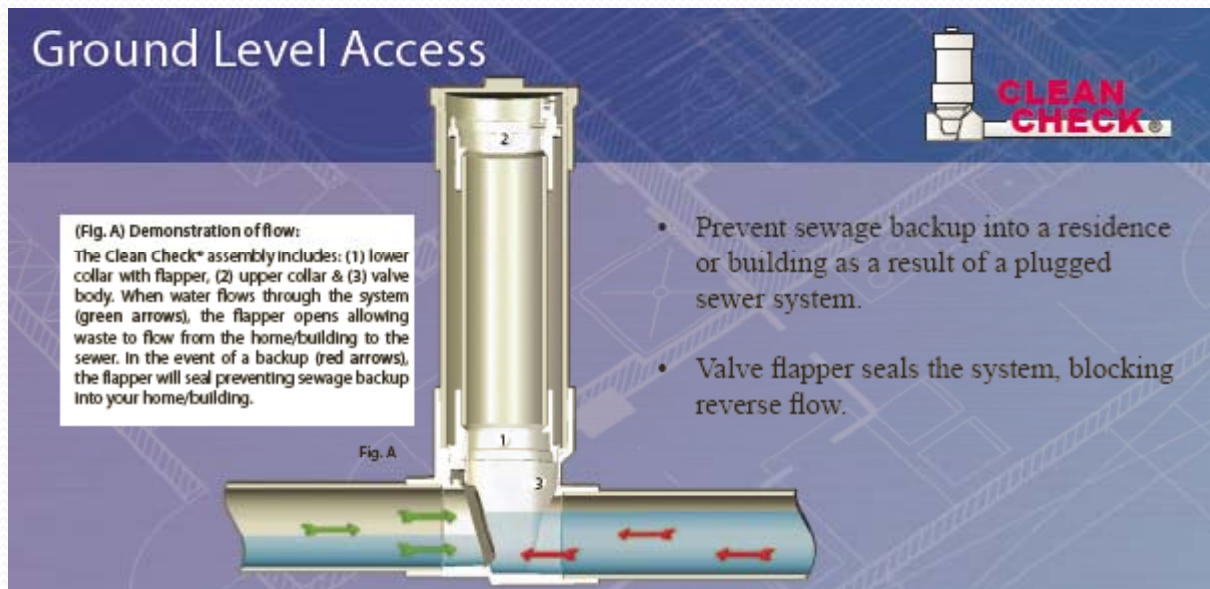
STAND PIPE

- INSTALLED WITHIN FLOOR DRAIN
- HEIGHT OF THE STAND PIPE IS DICTATED BY PREVIOUS FLOODING
- ALLOWS WATER TO SEEK THE SURCHARGED ELEVATION
- ALL SANITARY FACILITIES NEED TO BE PROTECTED
- IF SANITARY PIPE IS DAMAGED BELOW THE SLAB THIS WILL NOT STOP SEWAGE BACK-UP.
- FLOOD GUARD BRAND
 - Plumbingsupply.com



BACKWATER VALVE

- BENEFITS
 - FLAPPER ACCESSED THRU RISER, MH NOT REQUIRED
 - PIPES UNDER THE HOUSE NOT SUBJECTED TO PRESSURE
- BRANDS
 - CLEAN CHECK (75 PSI MODEL AVAILABLE)
 - CANPLAS (CURRENT MODEL IS RATED AT 60 PSI)



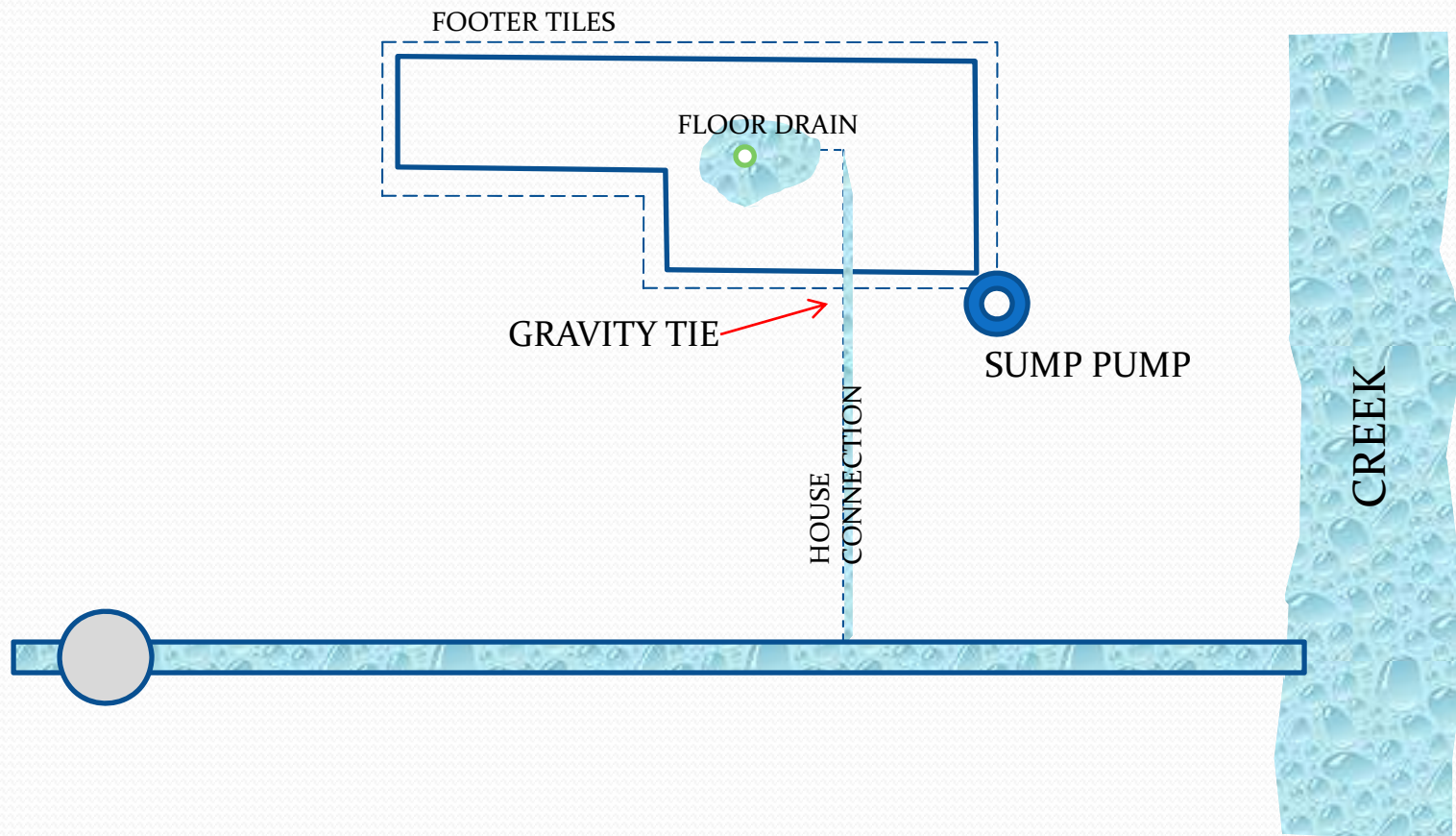


IMPROPER WATER MITIGATION FOR STORM WATER SURCHARGE

- STAND PIPE (USE FOR SANITARY ONLY)
 - FLOOR DRAIN IS PROTECTED
 - BASEMENT WILL FLOOD FROM FOUNDATION DRAIN (STORM)
- SUMP PUMP WITHOUT GRAVITY TIE DISCONNECT
 - BASEMENT WILL STILL FLOOD SINCE THE GRAVITY TIE IS NOT DISCONNECTED

SUMP PUMP WITH GRAVITY TIE

- BASEMENT WILL STILL FLOOD FROM THE FLOOR DRAIN



MAJOR FLOOD EVENT



FEMA

- THE FEDERAL GOVERNMENT DETERMINED THAT **FLOODS CAN NOT BE STOPPED**
- RECOMMENDATIONS
 - FEDERAL AND STATE
 - BUY FLOOD INSURANCE
 - CITY OF WESTLAKE
 - **FLOOD PROOF YOUR HOUSE**
 - MITIGATING WET OR FLOODED BASEMENT BROCHURE – INFORMATION AND SOLUTIONS
 - DEPARTMENT OF ENGINEERING WEB PAGE @ www.cityofwestlake.org



NATIONAL
FLOOD
INSURANCE
PROGRAM



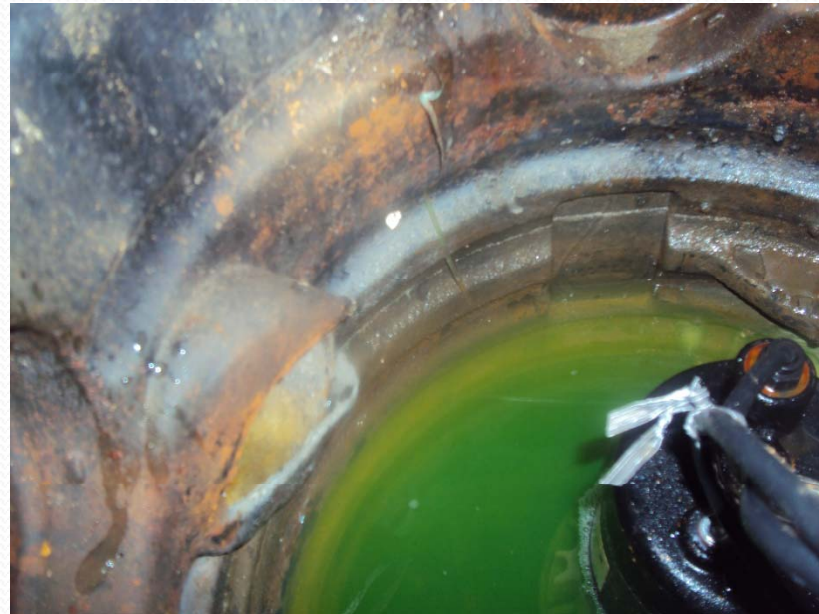
DYE TESTING PROGRAM

- **FREE** TO ALL RESIDENTS
- SERVICE DEPARTMENT LOCATES - CLEANOUTS
- TEST PERFORMED BY THE DEPARTMENT OF ENGINEERING
- SIMULATE A RAIN EVENT BY PLACING DYE AT VARIOUS DOWNSPOUTS
- CCTV INSPECTION OF STORM CONNECTION AND OTHER PLUMBING IF REQUIRED
- RECOMMENDATIONS GIVEN



2011 DYE TESTING

- DYE TESTS PERFORMED AS OF 6-8-11
 - >400
- OUTSTANDING TESTS THAT NEED TO BE COMPLETED
 - 200



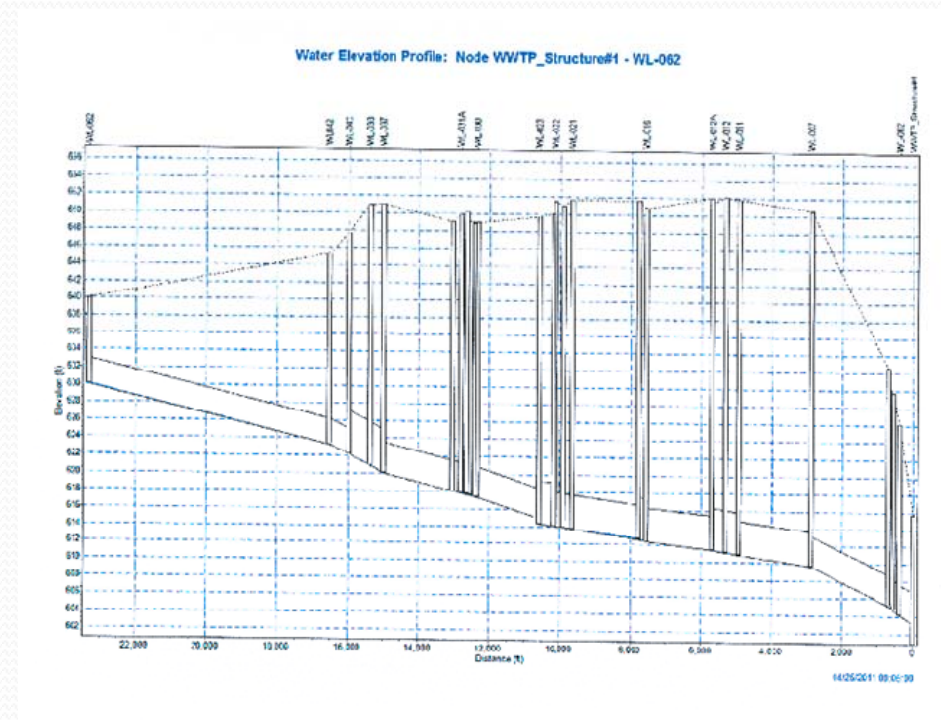


BASEMENT FLOODING

- ENGINEERING
 - HYDRAULIC MODELING OF THE INTERCEPTOR AND MAJOR SANITARY TRUNK LINES (URS)
 - IDENTIFY TRENDS FROM THE DYE TESTING RESULTS
 - CONSULT WITH PROFESSIONALS IN THE REDUCTION OF I/I
 - TEST BACKWATER VALVES AND CONSULT WITH THE MANUFACTURE'S
 - EXPLORE FURTHER I/I REDUCTION TECHNIQUES
 - MANHOLE INFLOW DISHES
- MAINTENANCE
 - BRUSH AND DEBRIS ALONG DOVER DITCH WAS REMOVED
 - VARIOUS STORM MAINS AND CATCH BASINS WERE CLEANED
- RESEARCH (FIELD CREWS DURING MAJOR RAIN EVENT)
 - SANITARY MANHOLES ARE MONITORED AND THE FLOW LEVELS ARE RECORDED FOR ANALYSIS
 - OBSERVE HOW THE INFRASTRUCTURE REACTS DURING THE RAIN
- ENFORCEMENT
 - MANDATORY DYE TEST FOR ALL WATERPROOFING PERMITS
 - INSPECTION TO VERIFY ALL DEFICIENCIES IDENTIFIED DURING DYE TEST ARE ADDRESSED,
- EDUCATION
 - DYE TESTING
 - “MITIGATING WET BASEMENT BROCHURE”

WWTP HYDRAULIC ANALYSIS

- URS
- REVIEW CHANGES TO THE WWTP MADE IN THE LATE 90'S
- HYDRAULIC MODEL
 - ALL CITY'S INTERCEPTORS AND MAJOR TRUNK LINES
 - WESTLAKE
 - INTERCEPTOR
 - SANITARY TRUNK LINES
 - CLAGUE
 - COLUMBIA
 - CANTERBURY
 - DOVER CENTER
 - CAHOON
 - BASSETT
 - CROCKER



BACKWATER VALVE TESTING

- CLEAN CHECK VALVES INSTALLED PREVIOUSLY FAILED
 - FLAPPER WAS ONLY RATED AT 5 PSI
- MANUFACTURER REDESIGNED THE FLAPPER TWICE
 - 15 PSI
 - >50 PSI
- THE 6" (15 PSI MODEL) WAS TESTED BY DEPARTMENT OF ENGINEERING
 - FLAPPER HELD WITH 17.5' OF WATER
- THE DEPARTMENT OF ENGINEERING WILL INFORM ALL RESIDENTS WITH LOW PRESSURE RATED FLAPPERS TO HAVE THEM REPLACED.



MANHOLE I/I

- VENTED LIDS IN AREAS WITH FLOODING CONTRIBUTE STORM WATER TO SANITARY
- INFLOW DISH REDUCE INFLOW INTO MANHOLE



MAINTENANCE

- ENGINEERING DEPARTMENT
 - WORK ORDERS
 - COMPLAINTS
 - DYE TESTING
 - CONSTRUCTION
- SERVICE DEPARTMENT
 - MAJOR DITCHES
 - CULVERTS
 - 29 CITY RETENTION BASINS
 - STORM MAINS
 - CURB INLETS
 - SANITARY MAINS



FUTURE PROJECTS

- WESTHILL / ALLEN SANITARY REHABILITATION PROJECT
- CITY WIDE MANHOLE REHABILITATION PROJECT
- SANITARY MANHOLE INFLOW DISH PROGRAM
- CITY WIDE FLOW METERING PROJECT
- BRADLEY ROAD RELIEF DITCH EXTENSION
- MODIFICATIONS IF REQUIRED TO THE WWTP



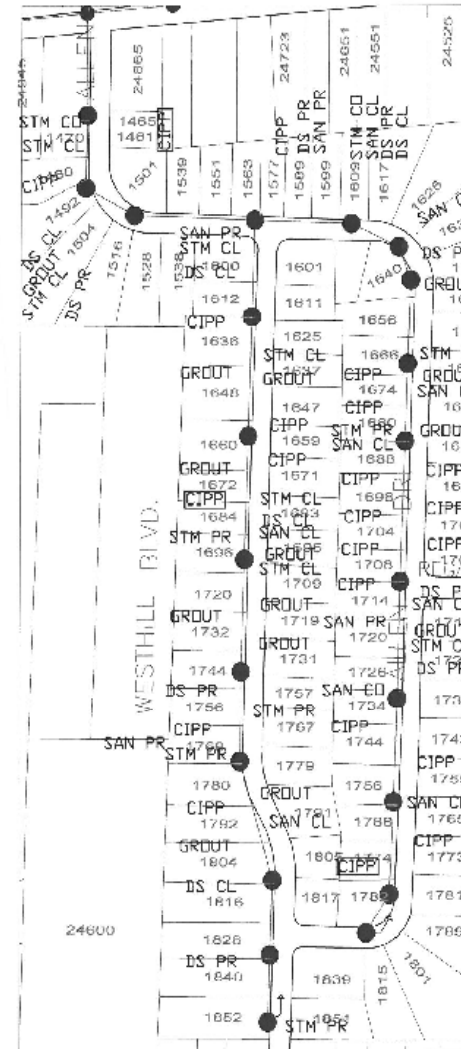
FUTURE PROGRAMS

- MAJOR DITCH INSPECTION
 - ALL MAJOR DITCHES WILL BE INSPECTED EVERY 2 YEARS
- RETENTION BASIN INSPECTION
 - ALL 350 PRIVATE BASINS WILL BE INSPECTED EVERY 3 YEARS
 - CAPACITY RESTRICTION ISSUES
 - FUNCTIONALITY
 - CLEAN WATER
 - MAINTENANCE



WESTHILL / ALLEN SANITARY REHABILITATION

- UNITED SURVEY INC.
- SANITARY MAINLINE REHABILITATION
 - CHEMICAL GROUTING
 - SECTIONAL LINING
- SANITARY MANHOLE REHABILITATION
 - GRADE RING SEALING
 - VENTED LIDS
- SANITARY CONNECTION REHABILITATION
 - CURED IN PLACE PIPE-SANITARY
 - POINT REPAIRS- BOTH STORM AND SANITARY
 - CLEANING STORM CONNECTIONS
- STORM MAIN REHABILITATION



LEGEND

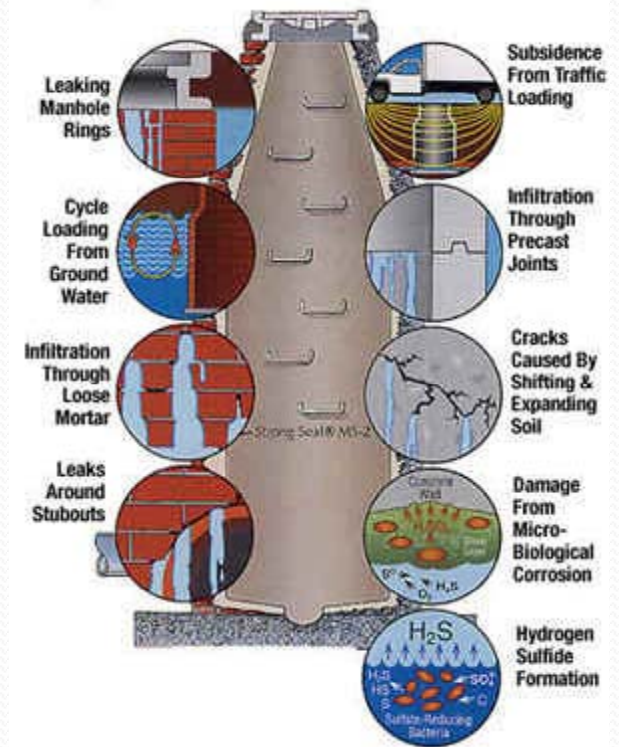
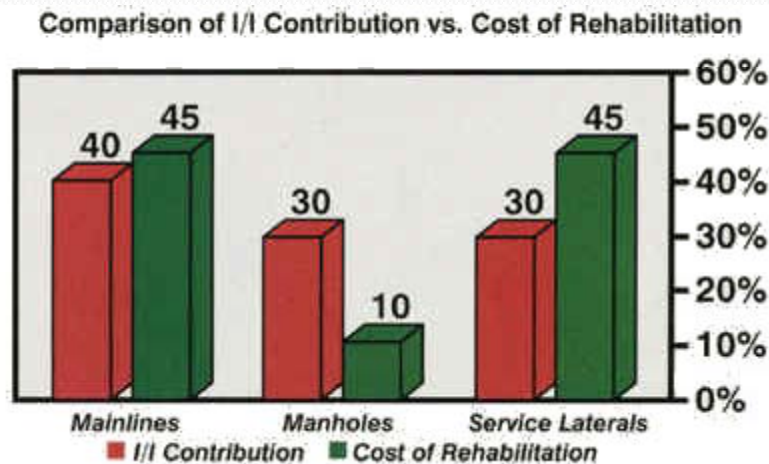
| | |
|--------|--------------------------------|
| CIPP | LATERAL LINING (MAIN TO HOUSE) |
| CIPP | LATERAL LINING (MAIN TO CO) |
| SAN CO | INSTALL SANITARY CLEANOUT |
| STM CO | INSTALL STORM CLEANOUT |
| SAN PR | SANITARY LATERAL POINT REPAIR |
| STM PR | STORM LATERAL POINT REPAIR |
| SAN CL | SANITARY LATERAL CLEANING |
| STM CL | STORM LATERAL CLEANING |
| DS PR | DOWNSPOUT LEADER POINT REPAIR |
| DS CL | DOWNSPOUT LEADER CLEANING |
| GROUT | LATERAL CHEMICAL GROUT |

NOTES:

THIS PLAN IS FOR REFERENCE ONLY. THE SUBSEQUENT FIGURES SHALL BE USED TO DETERMINE THE ACTUAL WORK TO BE PERFORMED AT EACH HOUSE.

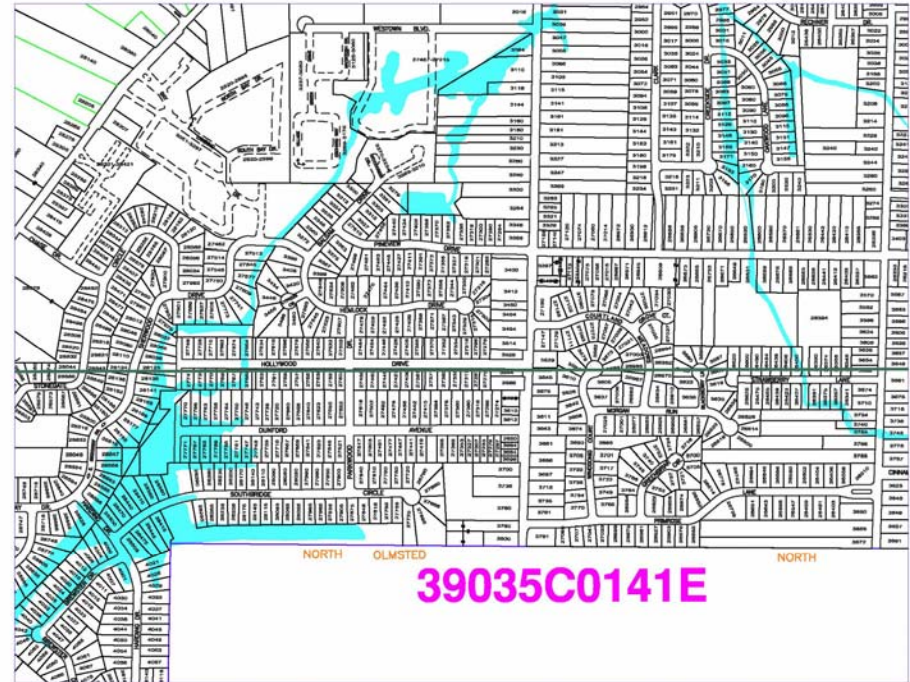
CITY WIDE MANHOLE REHABILITATION PROJECT

- 30%-50% OF I/I IS FROM SANITARY MANHOLES
- INSPECT ALL 2500 SANITARY MANHOLES IN THE CITY
 - UTILIZING IN HOUSE STAFF
 - STRUCTURAL ISSUES
 - I/I ISSUES
- REHABILITATION PROJECT (PHASE 1)
 - OUT TO BID SPRING 2012



SANITARY MANHOLE INFLOW DISH PROGRAM

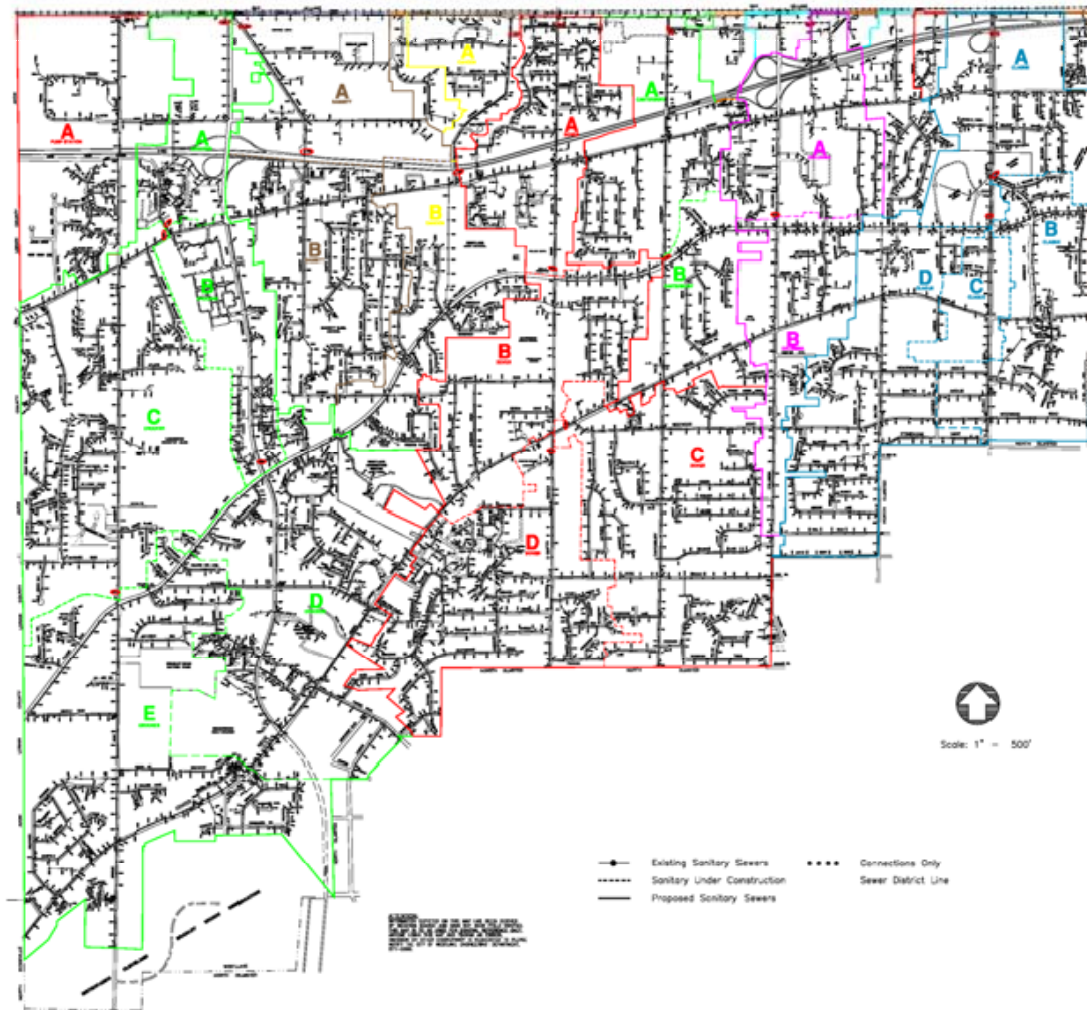
- TARGET AREAS WITH SEVERE FLOODING
- INSTALLED BY CITY FORCES
 - NO TOOLS
 - NO SPECIAL SKILL
- IMMEDIATE RESULTS



CITY WIDE FLOW METERING

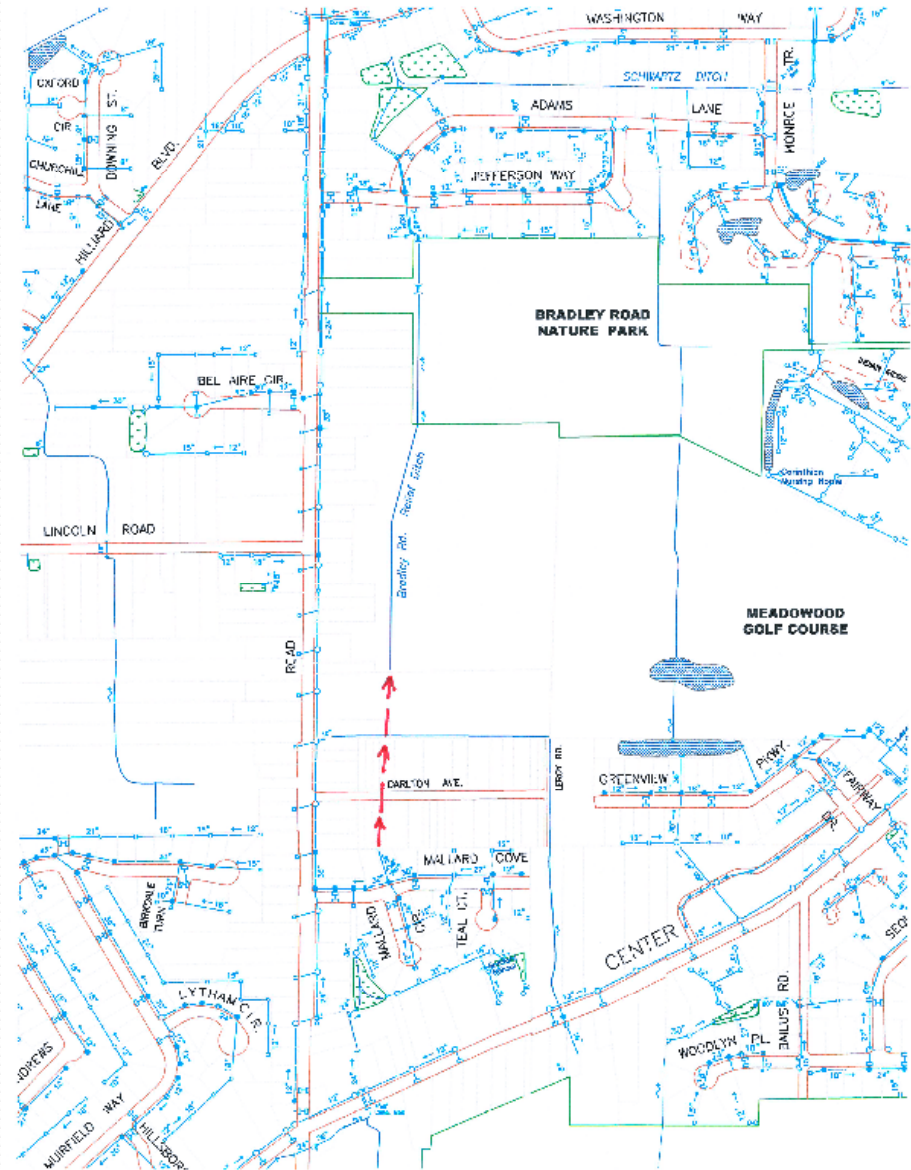
- FALL 2011 – SPRING 2012
- 23 FLOW METERS
 - 60 DAYS OF MONITORING
- SUB-BASINS FROM EACH OF THE MAJOR TRUNK LINES
 - CLAGUE
 - COLUMBIA
 - CANTERBURY
 - DOVER CENTER
 - CAHOON
 - CROCKER / BASSET
- PRELIMINARY ESTIMATE
 - \$130,000

SANITARY DRAINAGE AREA MAP – CITY OF WESTLAKE



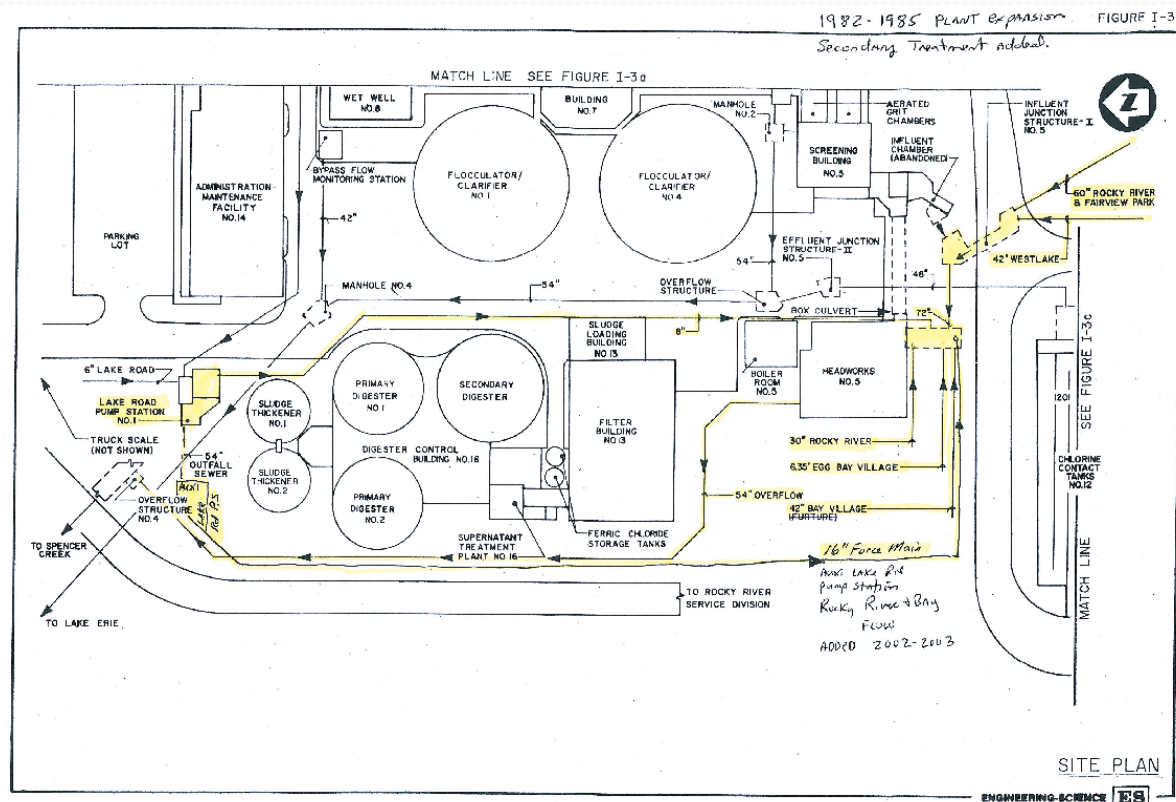
BRADLEY ROAD RELIEF DITCH

- EXTEND DITCH TO MALLARD COVE
- INCREASES STORM CAPACITY ON BRADLEY ROAD



WWTP MODIFICATIONS

- COLLECTION SYSTEM WAS MODIFIED AT HEADWORKS
- OVERFLOW WEIR ELEVATION WAS MODIFIED(2000)
 - 603.8' TO 605.29' T.O.P. OF INTERCEPTOR 604.87'



THE END

- QUESTIONS OR COMMENTS

