National Experience. Local Focus.

ESRI User Conference 2017

Using ESRI's ModelBuilder to Track Developments and Initiate Infrastructure Projects

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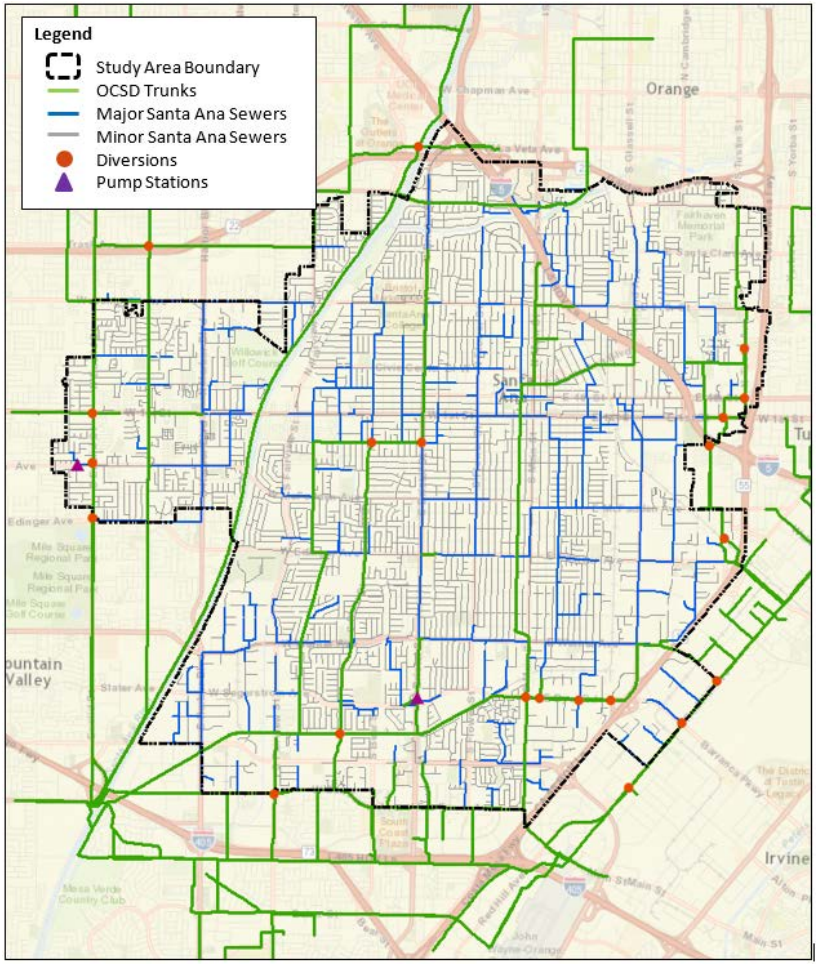
ESRI 2017 User Conference

Infrastructure Project Tracker - Agenda

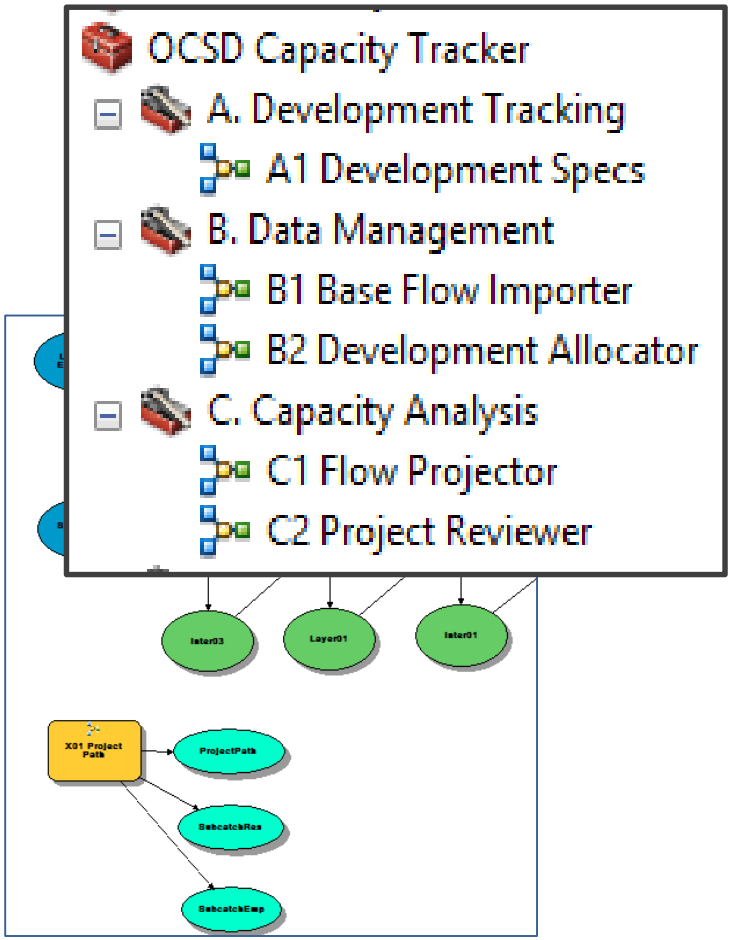
1. Background and Key Goals
2. Business Use Cases
3. Making Decisions
4. Tool Design:
   a. Development Tracker
   b. Data Validation
   c. Project Tracker
5. Tool Implementation
6. Tool Demo



Infrastructure Project Tracker

Background and Key Goals

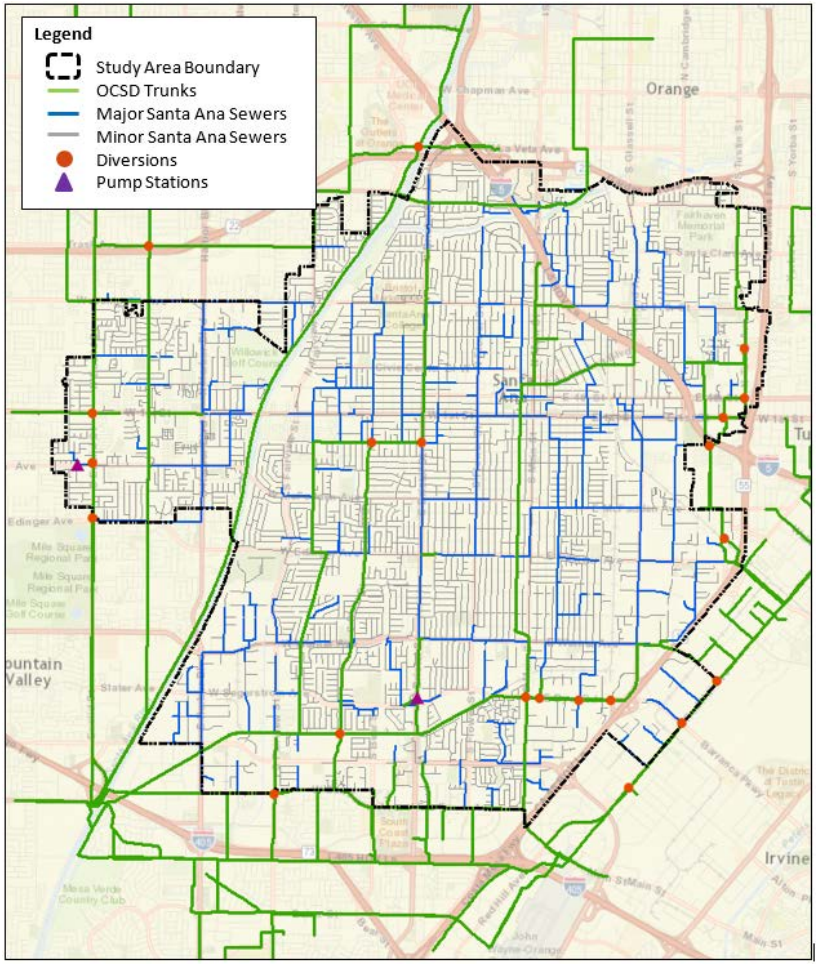
- **Evaluate sewer infrastructure based on changing land use and growth:**
  - Future flow projections are less reliable
  - Changing flows resulting from conservation
  - Oversized facilities based on old projections
- **Upgrade sewer infrastructure 'as-needed':**
  - Tracking on-going developments
  - On-going verification of CIP needs
  - Predict timing of CIP projects
  - Allocating capacity fees
- **Use ModelBuilder to streamline the process:**
  - Simple tools built into ArcGIS
  - Custom database to store data and results
  - Integrate with hydraulic model



Infrastructure Project Tracker

Using the Hydraulic Modeling

- **Update previous hydraulic model to include:**
  - Changes in base flows
  - Revised flow projections
  - Latest development projects
  - Recent sewer improvements
  - OCSD trunk network
- **Conduct flow monitoring:**
  - Verify latest base flows
  - Assess changes in I&I
- **Use model to update and prioritize CIP:**
  - Revise capacity improvements
  - Optimize diversion settings
  - Develop CIP budget



Infrastructure Project Tracker

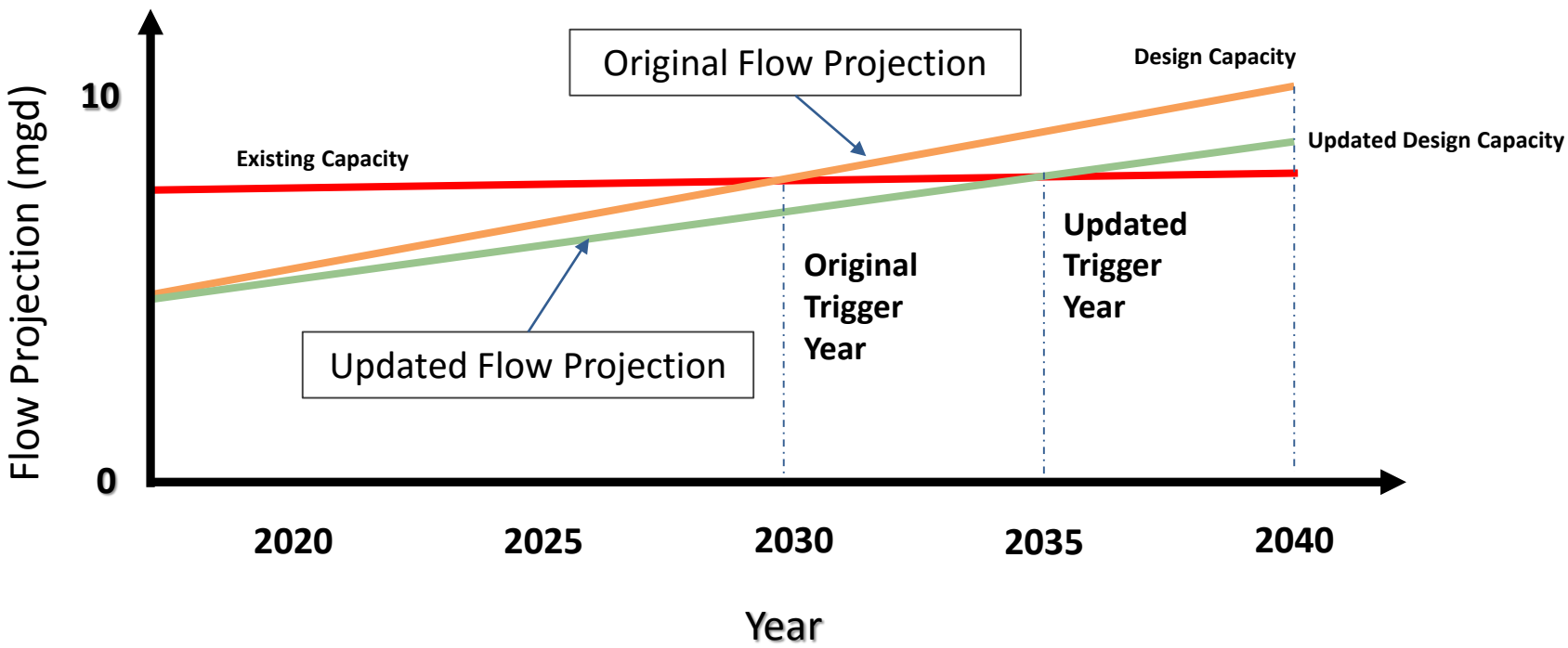
Making Decisions

- **General decision process for evaluating CIP projects**
  - Receive request
  - Get data
  - Conduct analysis
  - Prepare report
  - Conduct internal review
  - Make decision – to build, defer or cancel project

- **Issues with current practice:**
  - CIP projects are only re-evaluated when master plans are updated
  - No policy / procedure for interim CIP updates
  - Difficult to track developments within member agencies
  - Difficult to associate CIP with flows generated from multiple developments
  - Difficult allocating CIP costs to developers / agencies

Making Decisions

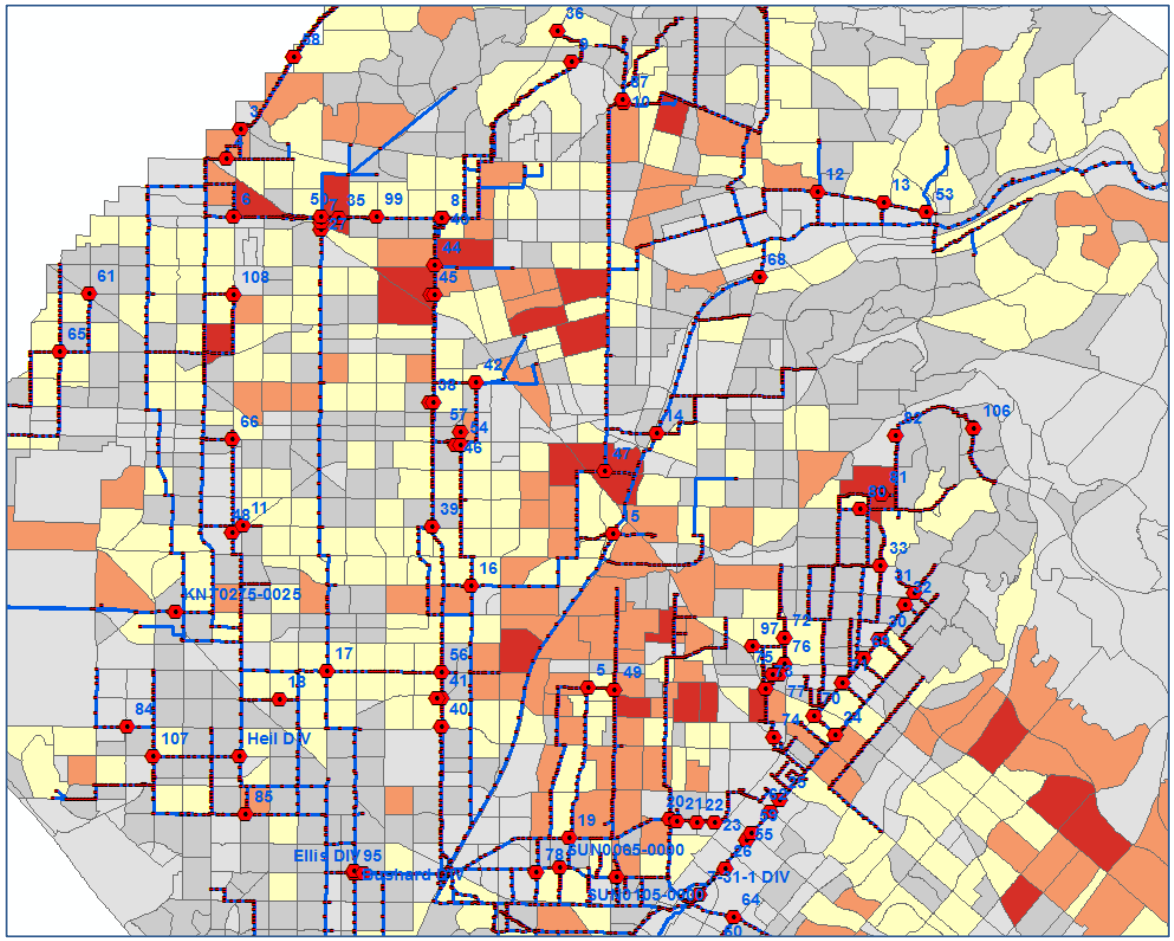
What's the Problem? – Tracking Growth



Tracking Development Growth

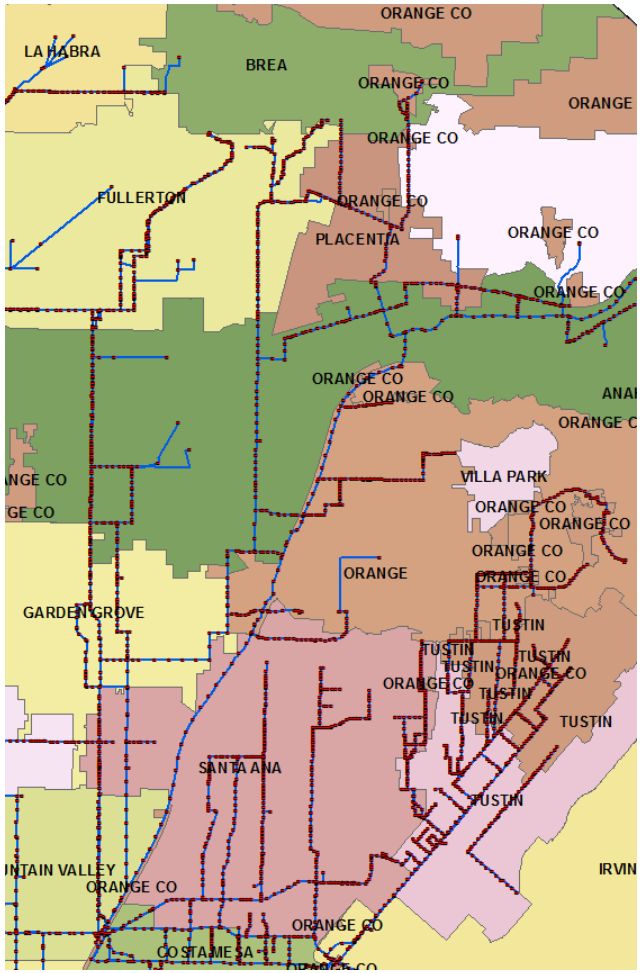
Model Flows – CDR Population Projections

- **Population data provided by Center of Demographic Research (CDR)**
- **Population projections:**
  - Residential – 2015
  - Residential – 2040
  - Employment – 2015
  - Employment – 2040
  - Other years included: 2020, 2025, 2030, 2035



Tracking Development Growth

Step 1: Obtained Developments from Agencies



Agency	Data Requested	Points of Contact
City of Orange	Sewer System GIS	Neil Millward (GIS Analyst)
	Sewer Master Plan	George Liang (Eng. PW)
	Land Use - Major developments	Jennifer Lee (Planning)
City of Garden Grove	Sewer System GIS	Josepgh Schwartz (GIS Analyst)
	Sewer Master Plan	Myung Chun & Scott Lo (Eng. PW)
	Land Use - Major developments	Alana Chang & Maira Parra (Planning)
City of Fountain Valley	Sewer System GIS	Patrick Mullen (Private GIS Consultant)
	Sewer Master Plan	Cal Youngberg (City Sewer Dept.)
	Land Use - Major developments	n/a
City of Anaheim	Sewer System GIS	Keith Linker (Eng. PW)
		Khanh Chu (PW)
		Jonathan Hefferman (PW)
	Sewer Master Plan	n/a
	Land Use - Major developments	Susan Kim (Planning)
City of Fullerton	Sewer System GIS	----
	Sewer Master Plan	----
	Land Use - Major developments	n/a
City of Westminster / Midway SAN District	Sewer System GIS	Ken Robbins (Eng. PW)
	Sewer Master Plan	n/a
	Land Use - Major developments	Chris Wong (Planner)
Yorba Linda WD / City of Yorba Linda	Sewer System GIS	Alfredo Vargas (GIS Analyst)
	Sewer Master Plan	Anthony Manzano (Eng.)
	Land Use - Major developments	Greg Rehmer (Planner)
OCSD	Class 1 & 2 Permitted SIU Database	Roya Sohanaki (Env. Compliance Div.)
	Project 2-72B & 2-72C (on-going)	Raul Cuellar (CIP Manager)
		Vicki Francis (Sr. Eng.)
Center for Demographic Research (CDR)	Current OCP TAZ Population Projections; Follow-up development research.	Deborah Diep (Director)
		Steven Ayers (Asst. Director)

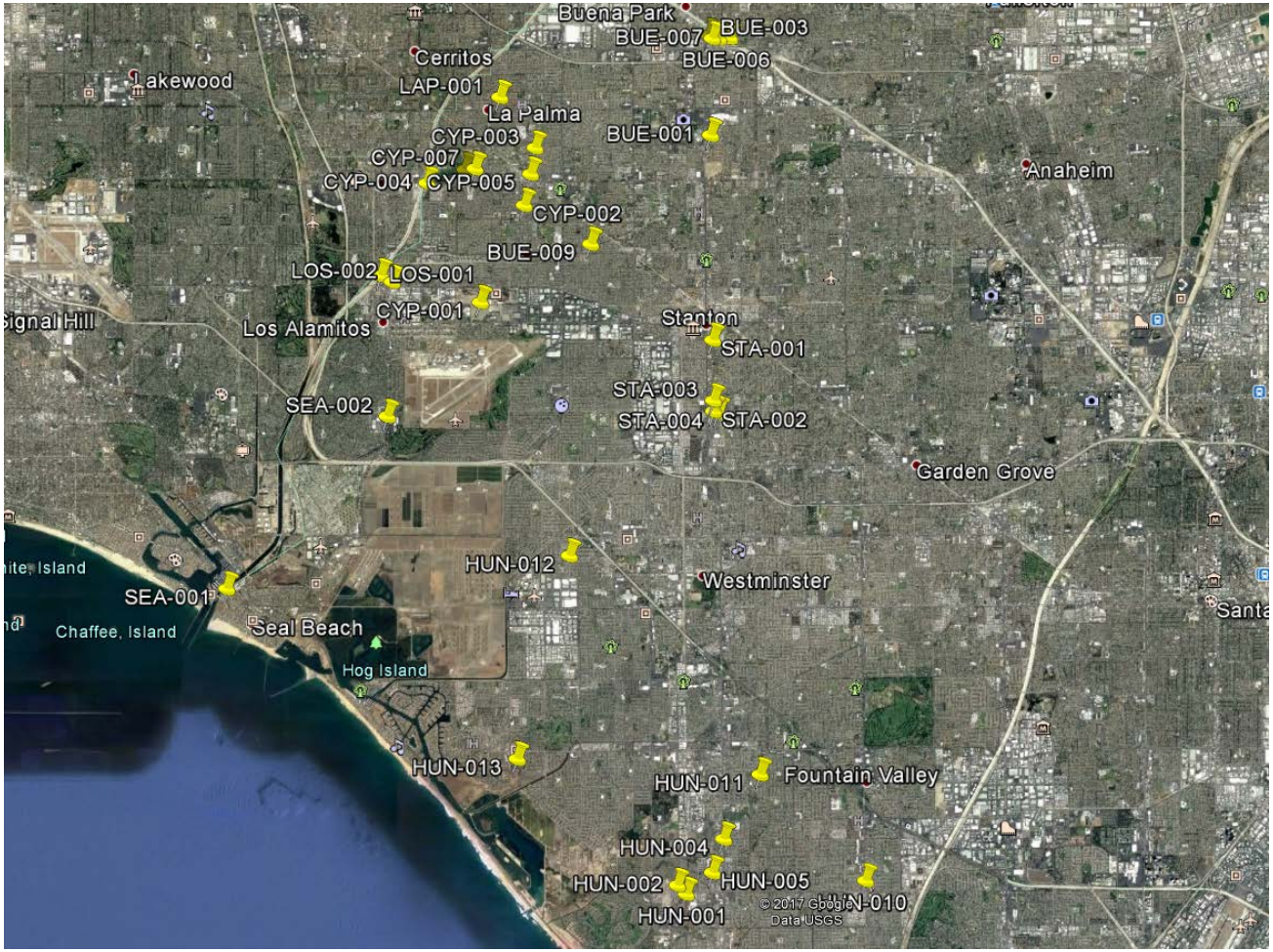
Tracking Development Growth

Step 2: Compared Developments with CDR

Project DU		Project Res. Population		Project Sq.Ft.		Project Emp. Population		CDR TAZ Forecast Data*						Project Included
Planned	Developed	DU Conversion (Persons/DU)	Planned	Planned	Developed	SqFt Conversion (employees/TSF)	Planned	DU2015	DU2040	RPOP15	RPOP40	EMP2015	EMP2040	
		2.66	28			NA	0	724	724	1924	1919	89	92	
		3.37	28			NA	0	347	347	1162	1158	61	61	NO
		3.68	8			NA	0	156	156	572	570	89	93	
21	0		64	0	0		0	1227	1227	3658	3647	239	246	
0	0	NA	0	425000	0	2.75	1169	1	1	3	3	408	428	NO
0	0	NA	0	153766	0	2.5	384	1	1	2	2	936	2275	NO
220	0	4.25	935	18000	0	3.5	63	1090	1340	4237	5449	656	776	YES
		2.53	66				546	1873	1918	4702	4780	426	481	
		4.61	600				2730	149	168	704	760	3673	3734	
		4.50	587				2730	3	3	9	9	3518	3614	
		5.26	412				1638	212	217	1101	1126	2367	2431	
		3.20	167				1092	1025	1087	3273	3438	558	650	
		3.27	170				1092	1178	1178	3832	3821	1538	1585	
		2.73	142				1092	1201	1201	3188	3179	188	191	
		4.48	817				3822	71	71	318	318	1439	1516	
		0.00	NA				2730	0	0	0	0	1798	1866	
		1.50	391				5460	4	4	6	6	5391	5496	
		2.94	383				2730	698	698	2015	2009	411	425	
		0.00	NA				2730	0	0	0	0	6395	6540	YES - not full buildout
		2.43	570				4914	4	254	10	605	3328	5761	
		4.00	521				2730	1	1	4	4	6254	7454	
		1.88	440				4914	8	8	15	15	11878	12104	
		0.00	NA				2184	0	0	0	0	4089	5339	
		2.96	386				2730	169	169	491	489	246	258	
		2.29	298				2730	629	1885	927	3910	4249	5294	

Tracking Development Growth

Step 3: Add Missing Developments to Model



Making Decisions

Focused Business Decisions

- **Key business decisions for managing capital improvements:**
  - Determine **size** of capacity improvements to convey development flows
  - Determine **when** to build capacity improvements
  - Proportion **cost** of capacity improvements to developers / agencies

- **Secondary needs:**
  - Track development requests – location, flows and status
  - Integrate hydraulic model with development analysis process
  - Dynamically update CIP listing based on growth

Making Decisions

Verify Existing Capacity Improvements

- **Step 1 - Update hydraulic model:**
  - Obtain latest flow projections from CDR
  - Combine development flows with flow projections
  - Add flow projections to model
- **Step 2 – Evaluate existing and future flow scenarios**
  - Run model to determine capacity issues for dry and wet weather conditions
  - Run model for existing and future flow scenarios
  - Determine if previously identified capacity issues are still triggered (per d/D and surcharge criteria)
- **Step 3 - Evaluate proposed CIP solutions**
  - Run model with proposed CIP solutions (from master plan)
  - Determine if proposed solutions still meet future flows (2040) needs

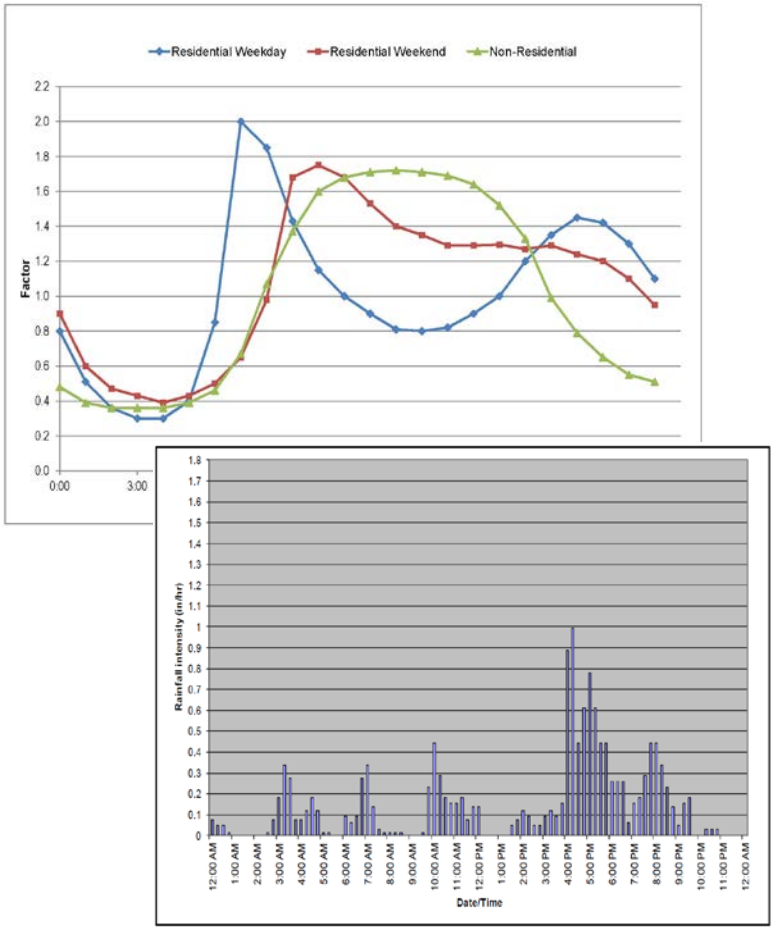
Making Decisions

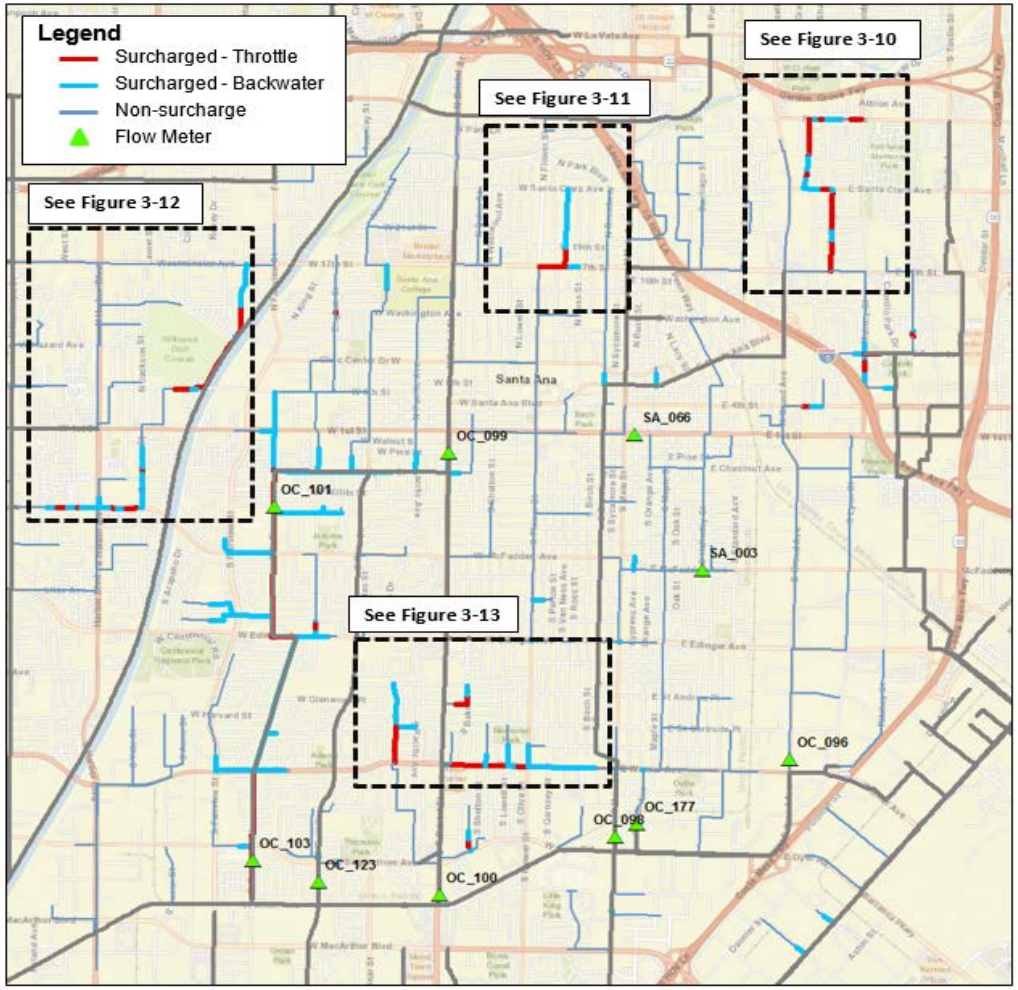
When to Build Capacity Improvements

- **Step 1 – Update Development Tracking Database:**
  - Collect latest development data (location, flows, dates, status)
  - Update periodically or per development application
- **Step 2 – Update Flow Projections**
  - Adjust base flow projections derived from capacity study
- **Step 3 – Compare Existing Capacities with Updated Flow Projections**
  - Extract capacities from hydraulic model and compare with new flows
- **Step 4 – Evaluate Improvement Trigger Year**
  - Interpolate trigger year
- **Step 5 – Verify Improvement Design Capacity**
  - Compare adjusted 2040 flow projections with existing design capacity

Hydraulic Modeling

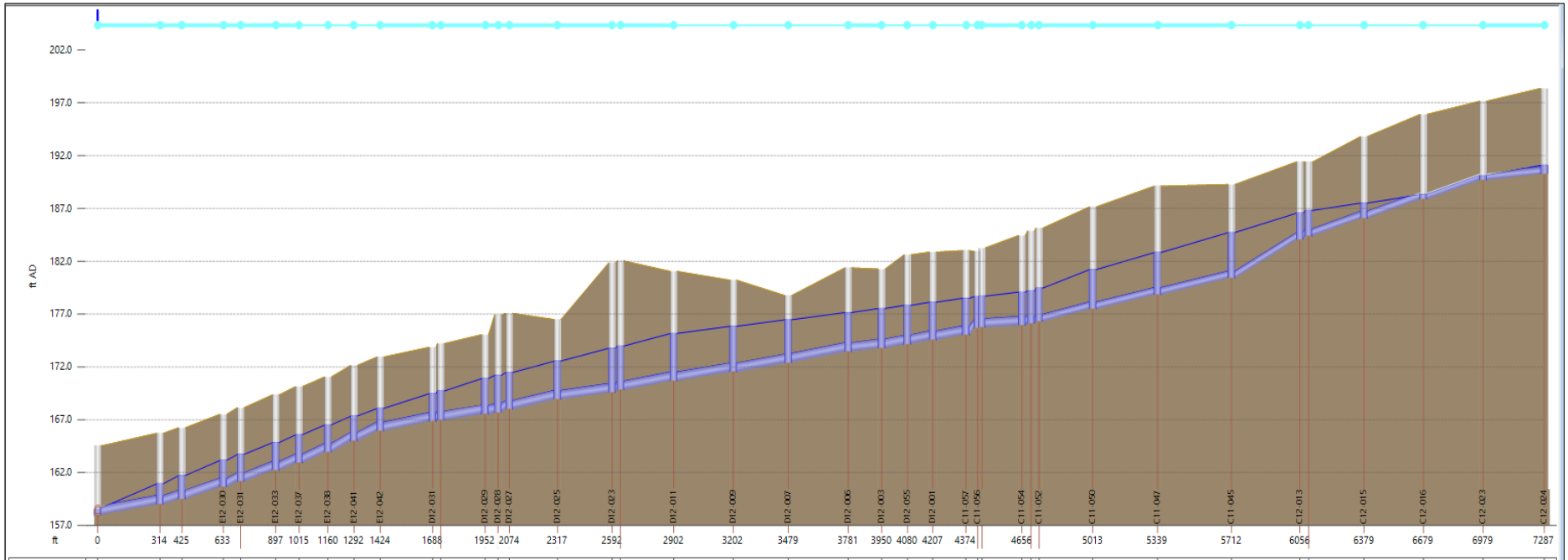
Evaluate Capacity using Hydraulic Models





Hydraulic Modeling

Finding Capacity Deficiencies

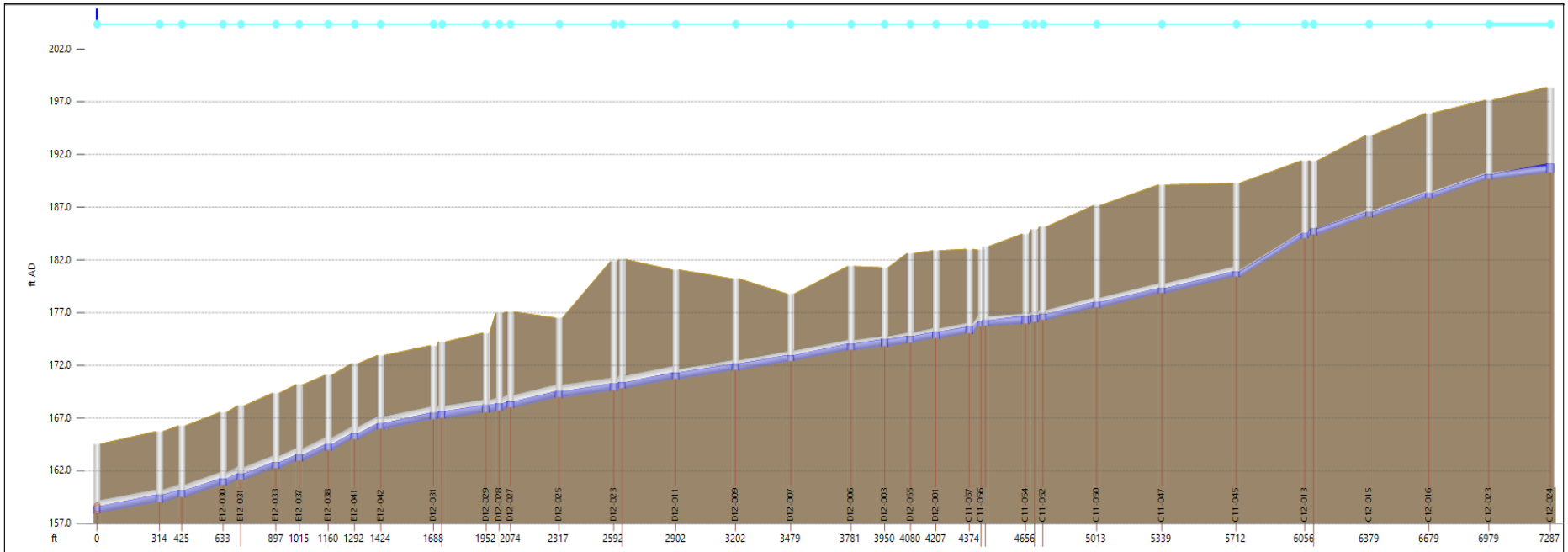


Link	E12-024.1	-	-	-	-	-	-	-	-	D12-031.1	-	-	-	D12-025.1	D12-023.1	D12-011.1	D12-009.1	D12-007.1	D12-006.1	-	-	-	-	-	-	-	C11-050.1	C11-047.1	C11-045.1	C12-013.1	-	C12-015.1	C12-016.1	C12-023.1	C12-024.1
height (in)	10.0	10.0	10.0	-	10.0	10.0	10.0	10.0	10.0	10.0	10.0	-	-	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	-	10.0	-	8.0	8.0	8.0	8.0	-	8.0	8.0	8.0	8.0
us inv (ft AD)	159.010	-	160.640	-	-	-	-	-	-	166.860	167.530	-	-	168.950	169.600	170.700	171.540	172.370	173.460	-	-	-	-	-	175.940	-	177.480	178.840	180.410	184.030	-	186.080	187.880	189.680	190.280
ds inv (ft AD)	158.030	-	159.510	-	-	-	-	-	-	165.960	166.980	-	-	168.000	168.950	169.830	170.700	171.540	172.460	-	-	-	-	-	175.750	-	176.310	177.480	178.840	180.410	-	184.390	186.080	187.880	189.680
pfc (MGD)	0.79	0.95	1.04	-	1.09	1.10	1.18	1.26	1.21	0.83	0.70	-	-	0.89	0.69	0.81	0.75	0.78	0.82	0.64	0.73	0.77	0.76	-	0.44	-	0.51	0.50	0.51	0.80	-	0.61	0.61	0.61	0.34
DS flow (MGD)	1.1849	-	1.1544	-	1.1022	-	-	-	-	1.0207	1.0194	-	-	0.9305	0.9298	0.9289	0.6584	0.6590	0.6672	0.6940	-	-	0.7123	-	0.6601	-	0.6647	0.5775	0.5789	0.5809	-	0.4029	0.4123	0.4117	0.4135
DS depth (ft)	0.610	-	2.223	-	2.565	-	2.667	2.579	2.371	2.120	2.743	-	-	3.479	3.610	4.151	4.473	4.307	4.010	3.690	3.732	-	3.553	-	2.952	-	3.147	3.736	3.989	4.312	-	2.414	1.425	0.430	0.420
Node	-	-	-	-	-	-	-	-	-	-	-	-	-	-	D12-025	-	-	D12-011	D12-009	D12-007	D12-006	-	-	-	-	-	-	-	C11-050	C11-047	C11-045	-	-	C12-015	C12-016	C12-023	-

Wright Street - Hydraulic Profile of Existing Sewer (2040 / Peak Wet Weather)

Hydraulic Modeling

Designing Capacity Improvements



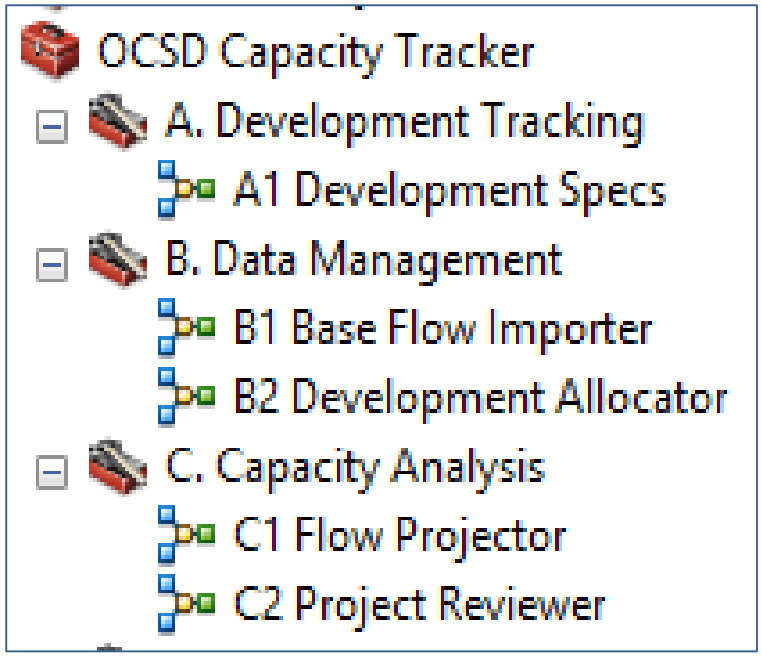
Link	E12-024.1	-	-	-	-	-	-	-	-	D12-031.1	-	-	-	D12-025.1	D12-023.1	D12-011.1	D12-009.1	D12-007.1	D12-006.1	-	-	-	-	-	-	-	C11-050.1	C11-047.1	C11-045.1	C12-013.1	-	C12-015.1	C12-016.1	C12-023.1	C12-024.1
height (in)	15.0	15.0	15.0	-	15.0	15.0	15.0	15.0	15.0	15.0	15.0	-	-	15.0	15.0	15.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	-	12.0	-	12.0	12.0	12.0	8.0	-	8.0	8.0	8.0	8.0
us inv (ft AD)	159.010	-	160.640	-	-	-	-	-	-	166.860	167.530	-	-	168.950	169.600	170.700	171.540	172.370	173.460	-	-	-	-	-	-	175.940	-	177.480	178.840	180.410	184.030	-	186.080	187.880	189.680	190.280
ds inv (ft AD)	158.030	-	159.510	-	-	-	-	-	-	165.960	166.980	-	-	168.000	168.950	169.830	170.700	171.540	172.460	-	-	-	-	-	-	175.750	-	176.310	177.480	178.840	180.410	-	184.390	186.080	187.880	189.680
pfc (MGD)	2.33	2.80	3.08	-	3.23	3.24	3.49	3.72	3.58	2.44	2.07	-	-	2.61	2.03	2.38	1.22	1.26	1.33	1.03	1.20	1.26	1.23	-	0.71	-	1.52	1.49	1.49	0.80	-	0.61	0.61	0.61	0.34
DS flow (MGD)	1.3504	-	1.3136	-	1.2481	-	-	-	-	1.1466	1.1467	-	-	1.0383	1.0384	1.0383	0.7637	0.7643	0.7646	0.7648	-	-	0.7654	-	0.7016	-	0.7023	0.6132	0.6139	0.6148	-	0.4111	0.4118	0.4120	0.4134
DS depth (ft)	0.579	-	0.616	-	0.543	-	0.541	0.525	0.507	0.532	0.631	-	-	0.548	0.549	0.545	0.583	0.578	0.480	0.556	0.638	0.556	0.570	-	0.483	-	0.517	0.487	0.451	0.451	-	0.556	0.416	0.419	0.420
Node	-	-	-	-	-	-	-	-	-	-	-	-	-	-	D12-025	-	-	D12-011	D12-009	D12-007	D12-006	-	-	-	-	-	-	-	C11-050	C11-047	C11-045	-	-	C12-015	C12-016	C12-023	-

Wright Street - Hydraulic Profile with Capacity Improvement (2040 / Peak Wet)

Tool Development

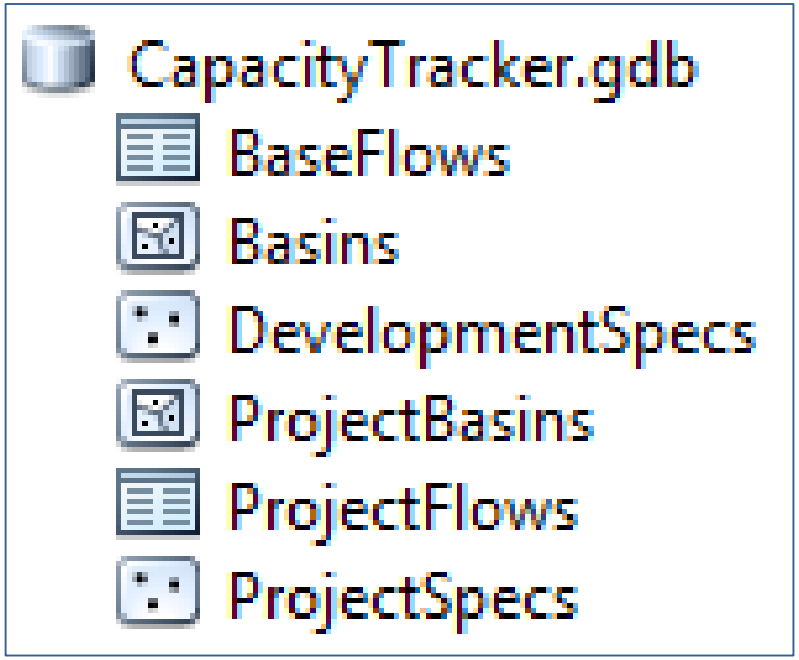
Designing Tools – Tool Architecture

- **Tool 1: Development Tracker:**
  - Development Specs
- **Tool 2: Data Importing and Validation:**
  - Base Flows
  - Development Flows
  - Project Specs
  - Project Basins
- **Tool 3: Flow Projection Update:**
  - Adjusted Flow Projections (per Project site)
- **Tool 4: Capacity Analysis:**
  - Capacity Analysis:
    - Exceedance Year
    - Revised Design Capacity



Tool Development

Designing Tools – Data Architecture



Field Name	Data Type
OBJECTID	Object ID
ProjectID	Text
PWWF2015	Double
PWWF2020	Double
PWWF2025	Double
PWWF2030	Double
PWWF2035	Double
PWWF2040	Double
TriggerYear	Text
TargetCapacity	Double

Tool Development
Tool 1: Development Tracker

- **Tool inputs:**
  - Development specs and flows obtained from developers and/or member agencies
- **Processing steps:**
  - Create a new Development Flow (point) feature class:
  - Manually collate and add new development flows:
    - Locate point matching development address
    - Add residential and commercial units
    - Calculate flows
    - Determine key dates (constructed, occupied)
    - Determine if development is included in CDR flow projection
- **Tool outputs:**
  - Development Specs – point feature class

Field Name
OBJECTID
SHAPE
DevID
Description
Agency
ResUnits
CommUnits
ADWF
PDWF
ProjectStart
ProjectEnd
SubID

Tool Development
Tool 2A: Base Flow Importing

- **Tool inputs:**
  - Hydraulic model results for existing and future
- **Processing steps:**
  - Create a new Base Flow feature class:
    - Feature type: Polygon (subcatchments)
    - Import model basins (subcatchments)
  - Run model for 2020, 2025, 2030, 2035 and 2040 peak wet flow scenarios
  - For each model run:
    - Export model result file (SHP format)
    - Import model results into Base Flow
  - For each Project Basin:
    - Calculate dry and wet-weather peaking factors
- **Tool outputs:**
  - Base Flows - polygon feature class

Field Name
OBJECTID
SubID
PeakFactorDW
PeakFactorWW
ADWF2015
ADWF2020
ADWF2025
ADWF2030
ADWF2035
ADWF2040

Tool Development
Tool 2B: Development Basin Allocator

- **Tool inputs:**
  - Development Specs feature class
- **Processing steps:**
  - Create a new Subcatchment ID column in Development Specs
  - For each development site:
    - Identify basin (subcatchment) polygon
    - Assign basin ID to development site
- **Tool outputs:**
  - Development Specs (with basin ID's) – point feature class

Field Name
OBJECTID
SHAPE
DevID
Description
Agency
ResUnits
CommUnits
ADWF
PDWF
ProjectStart
ProjectEnd
SubID

Tool Development
Tool 2C: Project Specs

- **Tool inputs:**
  - Capital improvement list or master plan
- **Processing steps:**
  - Create a new Project Specs point feature class
  - Manually enter project spec data including:
    - Name and description
    - Project ID and model ID (link ID)
    - Type (pipe, pump or other)
    - Existing capacity
    - Design capacity
  - Calculate flow factors for each project:
    - Dry weather peaking factor = DW peak flow / average dry weather flow
    - Wet weather peaking factor = WW peak flow / average dry weather flow
- **Tool outputs:**
  - Project Specs – point feature class

Field Name
OBJECTID
SHAPE
ProjectID
Name
Description
ProjectType
ExistingCapacity
DesignCapacity
PeakFactorDW
PeakFactorWW

Tool Development
Tool 2D: Project Basins

- **Tool inputs:**
  - Project basins defined from model network
- **Processing steps:**
  - Create a new Project Basins - polygon feature class
  - For each Project Site:
    - Manually select upstream basins draining to project site
    - For each basin, assign a flow factor (0 – 1) that represents how much flow contributes to the 'project network'. Normally, flow factor = 1 unless basin is split due to flow diversions
    - Use model trace tool to define upstream network and associated basins
- **Tool outputs:**
  - Project Basins – polygon feature class

Field Name
OBJECTID
Shape
SubID
Shape_Length
Shape_Area
P001
P002
P003
P004
P005

Tool Development
Tool 3: Flow Projection Update

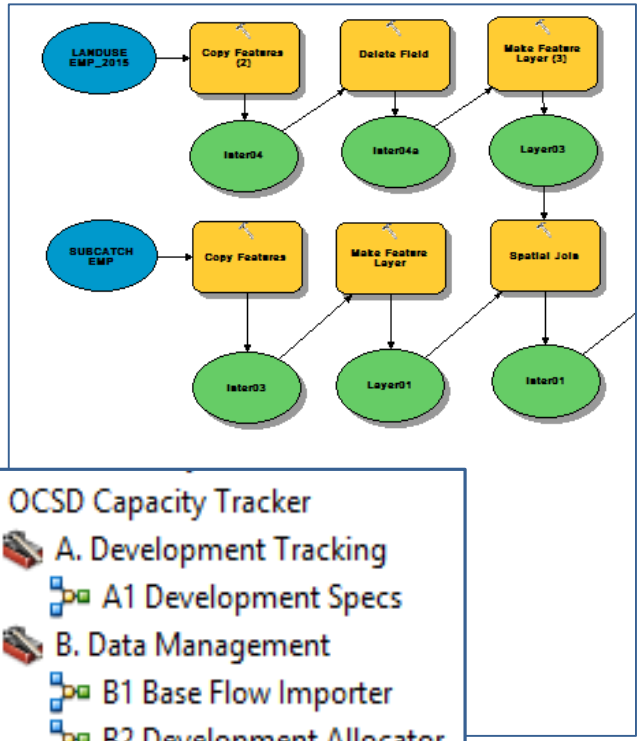
- **Tool inputs:**
  - Base Flows, Development Flows, Project Specs and Project Basins
- **Processing steps:**
  - For each Project Site > Year > Basin:
    - Existing Base Flow = model base flow x flow factor
    - Total Development Flow = sum development flows per basin
    - Adjusted Base Flow = Existing Base Flow + Development Flow
  - For each Project Site > Year:
    - Total Adjusted Base Flow = Sum of Adjusted Base Flows
  - For each Project Site:
    - Dry Weather Peak Flow = Total Adjusted Base Flow x DW Peaking Factor
    - Wet Weather Peak Flow = Total Adjusted Base Flow x WW Peaking Factor
- **Tool outputs:**
  - Project Flows – contains adjusted flow projections

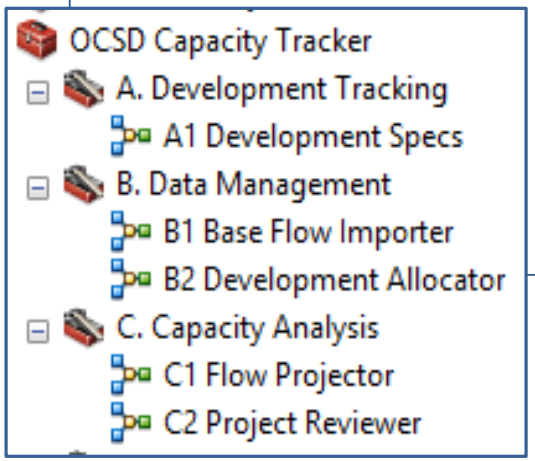
OBJECTID
ProjectID
PWWF2015
PWWF2020
PWWF2025
PWWF2030
PWWF2035
PWWF2040
TriggerYear
TargetCapacity

Tool Development

Model Building and GIS Analysis

- **ModelBuilder Approach**
  - Utilized existing InfoWorks model
  - Verified diversion settings
- **Population and Future Developments**
  - OCSD obtained and compiled development populations
  - Updated CDR 2040 projections
- **GIS Processing and ModelBuilder**
  - Applied model procedures
  - Procedures automate the modeling process
  - Utilized ArcGIS ModelBuilder to distribute populations





Tool Development
Tool 4: Capacity Analysis

- **Tool inputs:**
  - Project Specs and Adjusted Flow Projections
- **Processing steps:**
  - Add new columns to Adjusted Flow Projection feature class:
    - Updated Trigger Year
    - Updated Target Capacity
  - For each Project Site > Year:
    - Compare existing capacity with adjusted flow projections
    - Select projection year when flow exceeds capacity
    - Interpolate between 5-year projections to estimate trigger year
    - Compare 2040 adjusted flow projection with target (design) capacity
    - Update target capacity if adjusted 2040 flow exceeds current target capacity
- **Tool outputs:**
  - Capacity Analysis

Tool Development
ModelBuilder and Tool Demo