WEST YOST ASSOCIATES
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TECHNICAL MEMORANDUM

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SENT VIA: EMAIL

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SUBJECT: Impacts of Innovation Center/Nishi Property Development on Wastewater Collection System Capacity

The purpose of this technical memorandum (TM) is to present an assessment of the impacts of the proposed Innovation Center (IC) and Nishi Property Development projects on the City of Davis (City) wastewater collection system. The major topics covered in this TM include:

- Background Information
- Collection System Flow Estimation Methodology
- Davis Innovation Center
- Mace Ranch Innovation Center/Triangle
- Nishi Property
- Conclusions

BACKGROUND INFORMATION

The proposed development projects under investigation in this analysis include:

- Davis IC, located north of Covell Boulevard and west of Highway 113
- Mace Ranch IC, located east of Mace Boulevard and north of Interstate 80 (I-80)
- The Triangle, located adjacent to and immediately southwest of Mace Ranch IC
- Nishi property, located between I-80 and the Union Pacific Railroad tracks immediately south of the University of California, Davis (UC Davis) central campus

Because of their proximity to each other, the Mace Ranch IC project and the Triangle project are considered as a single project from the standpoint of collection system impacts in this analysis.

Sources of information relevant to the collection system impacts of the projects in question include:

1. A document titled "Draft Water Supply Assessment" [Brown and Caldwell, January 2015] ("2015 Draft Water Supply Assessment").
2. An undated technical appendix to the development project application for the Davis IC project [Cunningham Engineering] examining the sewer system impacts of that project ("Davis IC Sewer Analysis").
3. An internal City document titled "Nishi Project Description for NOP and City Council," dated January 7, 2015 ("2015 Nishi Project Description").
4. A PDF figure titled "Mace Ranch Innovation Center Sanitary Sewer" [Cunningham Engineering], dated November 20, 2014 ("Mace Ranch IC Figure").
5. The City Sewer System Management Plan, dated August 2012 ("2012 SSMP").
6. The City System Evaluation and Capacity Assurance Plan, dated April 2009 ("2009 SECAP").
7. A series of spreadsheet analyses maintained by City staff examining collection system flows at various locations throughout the City ("City Sewer Spreadsheets").

For this analysis, the land use and water demand information presented in the 2015 Draft Water Supply Assessment is considered to be representative of the proposed project. Where any inconsistencies exist with other information sources, the 2015 Draft Water Supply Assessment is assumed to take precedence.

COLLECTION SYSTEM FLOW ESTIMATION METHODOLOGY

In general, where direct flow measurements are unavailable, existing and future collection system flows are estimated based on the use of sewer flow factors in combination with existing and proposed land use information. For sewer lines, the key flow condition of interest is instantaneous peak wet weather flow (PWWF), which represents the worst-case flow condition that is likely to occur. The major steps in the estimation of the PWWF for any point in the collection system include:

1. Estimate the average dry weather flow (ADWF), which involves quantifying existing and future development conditions and applying appropriate flow factors to those quantities.
2. Estimate the instantaneous PDWF, which involves applying a suitable dry weather peaking factor to the ADWF.
3. Estimate the peak instantaneous infiltration and inflow (I&I) rate into the collection system associated with worst-case wet weather conditions. The PWWF is the sum of the PDWF and the peak instantaneous I&I.

Anticipated land uses associated with the proposed projects, as taken from the 2015 Draft Water Supply Assessment, are summarized in Table 1. Sewer flow factors in gallons per day (gpd) per unit, as taken from the 2012 SSMP, are summarized in Table 2. Land uses with immediate relevance to the four proposed development projects are indicated in italics in Table 2.

Table 1. Projected Land Use Totals for Future Development

Category	Units	Davis IC	Mace Ranch IC	Triangle	Nishi Property
Residential	population	0	0	0	1,755
Residential	dwelling units	0	0	0	650
Office	ft^2	2,400,000	1,510,000	45,901	264,712
Non-office	ft^2	1,280,000	884,000	0	88,238
Office/Non-office	employees	10,536	5,633	0	1,412
Retail	ft^2	120,000	100,000	25,155	47,950
Retail	employees	240	200	50	96
Retail	customers	5,301	2,842	1,200	1,705
Hotel	rooms	200	150	0	0
Convention Center	visitors	1,000	667	0	0
Hotel	ft^2	200,000	160,000	0	0
Hotel	employees	66	50	0	0
Open Space	acres	0	0	0	0

Source: Draft Water Supply Assessment, Brown and Caldwell, January 2015.

An alternative means of arriving at an estimate of ADWF for the projects in question involves the use of indoor water use estimates obtained from the 2015 Draft Water Supply Assessment. These estimates are included for comparison purposes in this TM.

The 2012 SSMP does not specify sewer flow factors for either retail customers or convention center guests, both of which are potentially significant for the Davis IC and Mace Ranch IC development projects. However, the 2015 Draft Water Supply Assessment specifies indoor water use factors of 3 gpd per customer/guest for both. That value is used in this analysis.

According to the 2012 SSMP, the calculation of a dry weather peaking factor used in the estimation of the PDWF involves the following exponential equation, where the flows are expressed in units of gpd:

$$PF = 7.67 \cdot ADWF^{-0.093}$$

(It should be noted that the 2012 SSMP contains a misprint showing an exponent of –0.93 rather than –0.093.) Accordingly, the PDWF can be calculated directly from the ADWF using the following equation:

$$PDWF = 7.67 \cdot ADWF^{0.907}$$

Table 2. City of Davis Sewer Flow Factors [(a)]

Description of Source	Type of Use	Unit	Flow Factor, gpd/unit
Auto Service Station	Commercial	Employee	15
Auto Service Station	Commercial	Auto	11
Bar	Commercial	Customer	2
Bar	Commercial	Employee	15
Country Club	Recreation	Member	55
Hospital	Industrial	Bed	175
Hospital	Industrial	Employee	15
Hotel	*Commercial*	*Employee*	*15*
Hotel	*Commercial*	*Guest*	*55*
Industrial Offices	Commercial	Employee	15
Laundry (self-serve)	Commercial	Machine	600
Laundry (self-serve)	Commercial	Wash	55
Motel	Commercial	Employee	15
Motel	Commercial	Guest	35
Motel with kitchens	Commercial	Guest	55
Office (Typical)	*Commercial*	*Employee*	*15*
Residential, Single-Family	*Residential*	*Unit*	*330*
Residential, Multiple-Family	*Residential*	*Unit*	*230*
Restaurant	Commercial	Meal	4
Retail (Typical)	*Commercial*	*Employee*	*15*
Retirement Home	Industrial	Employee	15
Retirement Home	Industrial	Resident	110
School	Industrial	Student	11
School with Cafeteria	Industrial	Student	16
School with Cafeteria and Gym	Industrial	Student	21
Shopping Center	Commercial	Employee	15
Shopping Center	Commercial	Toilet	550
Theater	Commercial	Seat	3

Source: City Sewer System Management Plan, August 2012.

[(a)] Italicized entries denote land uses with immediate relevance to the proposed development projects.

Finally, the calculation of the peak instantaneous I&I is based on the assumption that 600 gpd per acre is multiplied by the gross tributary area (A) in acres upstream of the point in question. Thus, the PWWF for any given point in the collection system is obtained as follows:

$$PWWF = 7.67 \cdot ADWF^{0.907} + 600 \cdot A$$

The 2009 SECAP mandates that the depth of flow (d) associated with the PWWF condition should not be more than 75 percent of the pipe diameter (D). This d/D ratio of 0.75 equates to a flow ratio of 90 percent. In other words, a trunk sewer should be considered at capacity if the PWWF is 90 percent of the full-pipe gravity flow capacity of that pipe.

DAVIS INNOVATION CENTER

The Davis IC Sewer Analysis presents average and peak sewer flow estimates that are specific to the project, while also presenting an analysis of available downstream capacity within the City's collection system. The key sewer lines of concern include the Covell trunk main and the downstream 42-inch diameter cross-country trunk sewer that runs parallel to and west of Pole Line Road north of Covell Boulevard. The Covell trunk main runs from west Davis to the 42-inch diameter cross country trunk sewer, and varies in diameter from 24 inches in west Davis, 30 inches in central/north Davis, and 36 inches east of F Street.

The City Sewer Spreadsheets also address the issue of available capacity in the trunk sewers downstream of the Davis IC project. The two analyses are not entirely consistent with each other, however. In general, the City Sewer Spreadsheets indicate higher downstream flows, even in the absence of the Davis IC project.

Another area of inconsistency exists between the land uses presented in the Davis IC Sewer Analysis versus those presented in the 2015 Draft Water Supply Assessment. Moreover, not all of the land use assumptions in the Davis IC Sewer Analysis are entirely clear. Therefore, the land use information from the 2015 Draft Water Supply Assessment is assumed to take precedence, as previously noted.

The Davis IC Sewer Analysis shows an estimated project-specific ADWF of 0.131 million gallons per day (mgd), with a corresponding PWWF of 0.501 mgd. Using the land use quantities specified in the 2015 Draft Water Supply Assessment in conjunction with the sewer flow factors specified in the 2012 SSMP produces a somewhat higher ADWF estimate of 0.193 mgd, with an associated PWWF of 0.600 mgd. Finally, using the indoor water use estimates from the 2015 Draft Water Supply Assessment produces an ADWF value of 0.322 mgd. Peak flows are not estimated in the 2015 Draft Water Supply Assessment; however, by using the previously-discussed peaking factor and I&I calculations, the associated PWWF would be 0.884 mgd.

The Davis IC Sewer Analysis also indicates a cumulative buildout ADWF in the 36-inch diameter portion Covell trunk main of 4.10 mgd, with an associated buildout PWWF of 9.63 mgd. According to that analysis, the associated capacity of the Covell trunk main is 11.4 mgd, such that the PWWF estimate equates to 84 percent of full-pipe capacity for that reach. The predicted worst-case capacity concern for any portion of the Covell trunk sewer was estimated to be in the 30-inch diameter portion just west of F Street, in which 88 percent of

full-pipe capacity was estimated for buildout PWWF conditions, which is just barely below the City's d/D standard (noted above) that correlates to 90 percent of full-pipe capacity. If the more conservative PWWF calculations from Davis IC just discussed are applied to the downstream trunk sewer assessment in the Davis IC Sewer Analysis, the most flow-restricted portion of the Covell trunk sewer would flow right at the 90 percent threshold for buildout PWWF conditions.

As noted above, City staff previously did their own calculations to estimate buildout flows throughout the Covell trunk sewer and downstream trunk sewers. That analysis uses flow and peaking factors that differ from those in the 2012 SSMP, and it does not include projected flows from the Davis IC project or the other proposed development projects discussed above. In the City's analysis, the cumulative buildout ADWF in the 36-inch diameter portion of the Covell trunk main was predicted to be 5.19 mgd, with an associated buildout PWWF of 11.02 mgd, which represents 97 percent of full-pipe capacity. (The City Sewer Spreadsheets indicate that the 42-inch diameter cross country trunk sewer is less flow-restricted than the Covell trunk main.) These flows are somewhat higher than those estimated in the Davis IC Sewer Analysis. Moreover, the expectation that the Covell trunk sewer would, under General Plan buildout development conditions, be flowing at 97 percent of full-pipe capacity exceeds the City's d/D standard of 0.75, which equates to 90 percent of full-pipe capacity, as noted above. Therefore, taken at face value, there is no capacity available in the Covell trunk sewer to accommodate any new development outside of the General Plan, and in fact, there is not even enough capacity to handle all of the future General Plan development.

It should be noted, however, that both the Davis IC Sewer Analysis and the City Sewer Spreadsheets predict a buildout ADWF in the 36-inch diameter portion of the Covell trunk sewer that is approximately as high as the current ADWF at the Davis Wastewater Treatment Plant (WWTP), and more than two thirds of the design ADWF for that facility. By comparison, the tributary area in question represents about half of the total development within the City. Moreover, the planned future development in areas tributary to the Covell trunk sewer represents only a small portion of the total buildout development. In other words, the vast majority of development in those areas has already occurred, such that future development (apart from the Davis IC) is minor in those same areas. It therefore appears that the City's flow factors significantly overestimate flows from at least some types of development. And given that residential land use is the dominant source of flow throughout the City, it is likely that the residential flow factors in the 2012 SSMP overestimate actual residential contributions.

One way to assess the accuracy of the City's flow factors is to consider current land use totals and flow rates City-wide. Existing land use quantities (as taken from the 2015 Draft Water Supply Assessment) and associated ADWF estimates based on the use of the City's sewer flow factors are shown in Table 3.

In a draft TM titled "Impacts of Innovation Center/Nishi Property Development on Wastewater Treatment Plant Capacity" (dated February 11, 2015), the current ADWF to the WWTP was calculated to be 4.34 mgd. The results in Table 3 show that using the City's flow factors from the 2012 SSMP, the calculated ADWF is nearly double the current ADWF at the WWTP. Moreover, the flow from the single-family residential category alone is calculated to generate more average flow than the current ADWF at the WWTP. It is thus concluded that the use of the City's current flow factors significantly overestimates the actual ADWF.

Table 3. Estimated Wastewater Generation from Existing Development City-Wide

Source	Units	Quantity	Flow Factor, gpd/unit	ADWF, mgd
Residential, Single-Family	Dwelling Units	14.516	330	4.79
Residential, Multiple-Family	Dwelling Units	12,080	230	2.78
Commercial/Institutional	Employees	37,500	15	0.56
Total	—	—	—	**8.13**

[a] From Draft Water Supply Assessment, Brown and Caldwell, January 2015.

With regard to the calculation of PDWF, the peaking factors calculation discussed above appears reasonable, and produces dry weather peaking factors that are generally consistent with similar peaking factor assumptions used by other agencies. Given that the PDWF calculation is based on what appears to be an overestimated ADWF, it is likely the resultant PDWF estimates are also unrealistically high.

In general, a lack of reliable instantaneous influent flow data at the WWTP are available due to influent pumping operations that do not perfectly mirror actual flows in the influent sewer. It is therefore difficult to estimate what the true peak City-wide I&I has been in recent years. The City Sewer Spreadsheets contain estimates of City-wide I&I of between 2.0 and 3.0 mgd, while the Davis IC Sewer Analysis shows a peak I&I of 2.0 mgd in the Covell trunk sewer. Observations by City staff indicate that during major storm events, WWTP influent flows do not spike upward dramatically, which suggests that these peak I&I estimates are reasonable and may even slightly overestimate peak I&I conditions.

The findings in Table 3 suggest that a 46 percent reduction in the City's collection system ADWF estimates is justified. If the ADWF estimates in the City Sewer Spreadsheets are conservatively reduced by 40 percent, then the most flow-restricted portion of the Covell trunk main shows a buildout PWWF that is only 66 percent of full-pipe capacity (rather than 97 percent), with 2.7 mgd of allowable capacity remaining. It is thus concluded that the buildout PWWF capacity in the Covell trunk sewer (and downstream trunk lines) is more than adequate to handle the additional flow generated by the Davis IC project according to the PWWF estimates presented in the Davis IC Sewer Analysis.

One additional point worth noting is that the language of the 2015 Draft Water Supply Assessment states that the land uses are expected to include "tech office facilities, research and development (R&D) and flex space, hotel/exhibition and visitor center facilities, and open space/landscaping." The tech office and R&D facilities language in particular provides sufficient latitude that the actual future uses of the Davis IC could be considerably more flow-intensive than the above flow numbers indicate. Therefore, even though it appears that adequate PWWF capacity is available in the Covell trunk main to accommodate the Davis IC project, it cannot be guaranteed that available capacity will be sufficient if actual wastewater flow generation rates are significantly higher than currently assumed.

MACE RANCH INNOVATION CENTER/TRIANGLE

At present, there are no analyses available that provide a detailed assessment of the collection system impacts of the Mace Ranch IC/Triangle. However, the Mace Ranch IC Figure (discussed above) shows that the Mace Ranch IC/Triangle projects would likely connect either directly to the 42-inch diameter gravity sewer north of the City (via a new 8-inch diameter sewer main flowing north from the eastern edge of the project site), or to the 21-inch diameter trunk sewer that conveys flows from south Davis (via a new sewer main flowing east from the eastern edge of the project site).

Estimated wastewater flow generation numbers from the Mace Ranch IC/Triangle project are shown in Table 4 for both a sewer flow factor basis and an indoor water use basis. The use of these two approaches results in a PWWF from the project of 0.427 mgd and 0.637 mgd, respectively.

Table 4. Projected Wastewater Flows from the Proposed Mace Ranch IC/Triangle Project

Category	Sewer Flow Factor Basis[a]	Indoor Water Use Basis[b]
ADWF, mgd	0.111	0.203
PDWF, mgd	0.290	0.500
I&I, mgd [c]	0.137	0.137
PWWF, mgd	0.427	0.637

[a] Based on land use totals from Table 1 and sewer flow factors from Table 2.
[b] Based on indoor water use totals from *Draft Water Supply Assessment, Brown and Caldwell, January 2015.*
[c] Based on an assumed gross area of 228 acres, per the 2015 Draft Water Supply Assessment.

According to the City Sewer Spreadsheets, the 42-inch diameter trunk sewer north of the City is predicted to flow at 88 percent of capacity at buildout PWWF conditions. Similarly, the 21-inch diameter trunk sewer serving south Davis is predicted to flow at 84 percent of capacity at buildout PWWF conditions. In light of the City's d/D standard of 0.75 specified in the 2009 SECAP, the remaining available capacity in these lines would be 0.31 mgd in the 42-inch diameter trunk sewer, and 0.28 mgd in the 21-inch diameter trunk sewer.

Taken at face value, there appears to be inadequate capacity available in either trunk sewer to accommodate the proposed development. However, as noted above, it appears that the City Sewer Spreadsheets significantly over-predict ADWF throughout the system. If the ADWF estimates in the City Sewer Spreadsheets are reduced by 40 percent (as per the findings in Table 3), then the 42-inch diameter trunk sewer would have approximately 5.0 mgd of allowable capacity remaining at General Plan buildout PWWF conditions, while the 21-inch diameter sewer would have approximately 1.4 mgd of allowable capacity remaining at General Plan buildout PWWF conditions. It is thus concluded that adequate buildout PWWF capacity exists in both lines to handle the additional flow generated by the Mace Ranch IC/Triangle project.

It should be noted, however, that the language of the 2015 Draft Water Supply Assessment states that the land uses are expected to include "research and office facilities, retail, and hotel/conference center facilities." This language provides sufficient latitude that the actual future uses of the Mace Ranch IC could be considerably more flow-intensive than the above flow numbers indicate. Therefore, even though it appears that adequate downstream PWWF capacity is available to accommodate the Mace Ranch IC/Triangle project, it cannot be guaranteed that available capacity will be sufficient if actual wastewater flow generation rates are significantly higher than currently assumed.

NISHI PROPERTY

The 2015 Nishi Project description indicates that that development project would discharge either to the UC Davis WWTP, located on Old Davis Road, or to the City wastewater collection system along Olive Drive. For this analysis, the latter discharge pathway is assumed. According to the 2015 Nishi Project Description, the gross area of the site is 57.7 acres.

As with the Davis IC, an area of inconsistency exists between the land uses presented in the 2015 Nishi Project Description versus those presented in the 2015 Draft Water Supply Assessment. Moreover, not all of the land use assumptions in the 2015 Nishi Project Description are entirely clear, and that document contains no estimate at all of generated sewer flows. Therefore, the land use information from the 2015 Draft Water Supply Assessment is assumed to take precedence, as previously noted.

Estimated wastewater flow generation numbers from the proposed Nishi Property Development are shown in Table 5 for both a sewer flow factor basis and an indoor water use basis. Using these two approaches results in a PWWF from the project of 0.477 mgd and 0.381 mgd, respectively. The City Sewer Spreadsheets indicate a PWWF of 0.483 mgd, which conforms closely to the sewer flow factor-based result in Table 5.

Table 5. Projected Wastewater Flows from the Proposed Nishi Property Development

Category	Sewer Flow Factor Basis[a]	Indoor Water Use Basis[b]
ADWF, mgd	0.177	0.135
PDWF, mgd	0.442	0.347
I&I, mgd [c]	0.034	0.034
PWWF, mgd	0.477	0.381

(a) Based on land use totals from Table 1 and sewer flow factors from Table 2.
(b) Based on indoor water use totals from *Draft Water Supply Assessment, Brown and Caldwell, January 2015.*
(c) Based on an assumed gross area of 57.7 acres, per the 2015 Nishi Project Description.

According to the City's utility mapping, an existing 8-inch diameter sewer currently serves the Olive Drive area. That line splits into a 6-inch diameter gravity sewer flowing north under the railroad tracks onto I Street, and an 8-inch diameter gravity sewer flowing north under the railroad tracks onto L Street. After picking up additional flows from the surrounding area, the two lines eventually reconverge at the intersection of 3rd Street and L Street. Thereafter, flows are conveyed in a 12-inch diameter gravity sewer to sewer lift station #4 (SLS-4), into which significant additional flows from surrounding areas are added. The resultant flows are then pumped to the 15-inch diameter L Street sewer main via a 14-inch diameter force main. The L Street sewer main then flows north, increasing to a 21-inch diameter pipe at Alice Street, before discharging into the Covell trunk sewer along Covell Boulevard.

Pipe slopes and capacities and existing PWWF estimates for the sewer facilities between Olive Drive and the Covell trunk main are not clearly indicated in the City Sewer Spreadsheets, although the City Sewer Spreadsheets do appear to indicate a pipe slope of 0.33 percent throughout the entire 8-inch diameter Olive Drive sewer. The full-pipe capacity of the 8-inch diameter Olive drive sewer would therefore be about 0.45 mgd. The existing PWWF from the Olive Drive area (apart from any future Nishi property flows) is not indicated in the City Sewer Spreadsheets.

Taken at face value, the capacity of the existing Olive Drive sewer would not be adequate to accommodate the projected Nishi Property Development PWWF shown in Table 5 when those flows are added to whatever existing flows are coming from the Olive Drive area. However, this conclusion is partially predicated on the accuracy of the PWWF prediction for the Nishi property development. As noted previously, it appears that the City flow factors significantly overestimate flows from residential sources, which are a significant component of the proposed Nishi development project.

Given the number of unknowns in the analysis, it cannot be determined whether adequate capacity is available in the existing Olive Drive sewer and in the sewer facilities further downstream without performing a more detailed analysis of the areas in question.

CONCLUSIONS

The major conclusions of this analysis are as follows:

1. The City sewer flow factors appear to significantly overestimate average wastewater flows from residential sources.
2. Using the City's design standards and flow calculations, the Covell trunk sewer appears to lack the capacity to accommodate the Davis IC development project. However, upon downward-adjusting the ADWF values in the City Sewer Spreadsheets by 40 percent (as appears justified from this analysis), there appears to be adequate PWWF capacity in the Covell trunk main to accommodate City General Plan buildout development plus the flow from the proposed Davis IC development project, assuming that actual project flows conform relatively closely to those assumed in this analysis.

3. Using the City's design standards and flow calculations, there would appear to be inadequate capacity in either trunk sewer to which the Mace Ranch IC/Triangle development project would connect. However, upon downward-adjusting the ADWF values in the City Sewer Spreadsheets by 40 percent (as appears justified from this analysis), there appears to be adequate PWWF capacity in all relevant trunk sewers to accommodate all general plan buildout development plus the flow from proposed Mace Ranch IC/Triangle development project, assuming that actual project flows conform relatively closely to those assumed in this analysis.
4. Inadequate information exists to determine whether sufficient capacity is available in the existing Olive Drive sewer and in the sewer facilities further downstream to accommodate flows from the proposed Nishi Property Development without performing a more detailed analysis of the areas in question.