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TECHNICAL MEMORANDUM

Date December 3, 2007
To: Jeff Wolf, P.E. City of Federal Way
From: Bruce Barker, P.E. MGS Engineering Consultants, Inc

Subject: *Hydrologic Assessment of Easter Lake Outlet Modifications*

OVERVIEW/BACKGROUND INFORMATION

The 1996 City of Federal Way Comprehensive Surface Water Management Plan[1] identified improvements to the outlet of Easter Lake to reduce the likelihood of flooding of lakeside structures. MGS Engineering Consultants analyzed the effectiveness of these improvements in 2003 using the Hydrological Simulation Program-Fortran (HSPF[2]) continuous hydrologic model. Subsequently, an additional flooding problem was identified by the City at a sag in the roadway located north of Easter Lake on S. 308th Street.

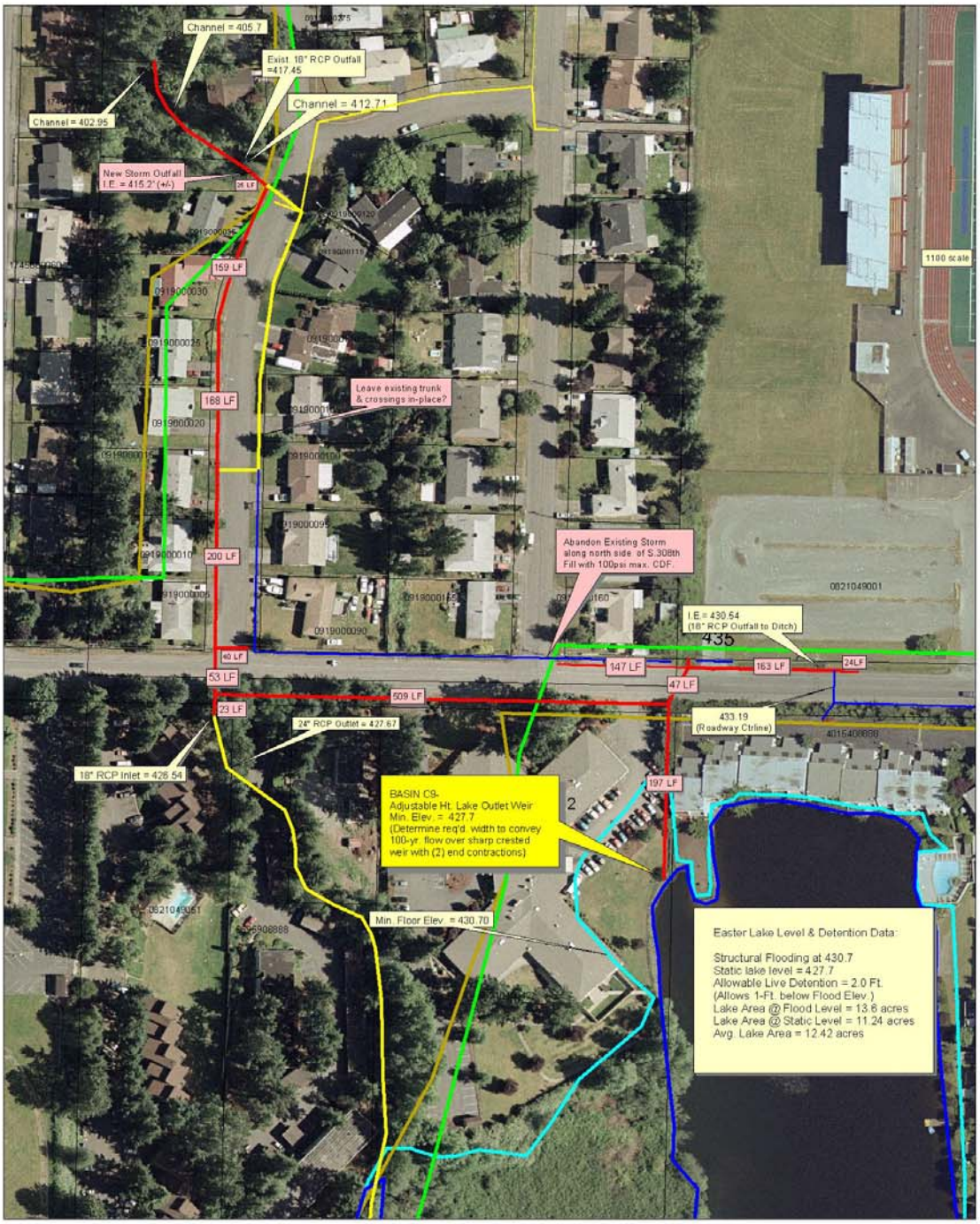
The City identified an additional option to alleviate the flooding along the lake shore and reduce the flooding along S. 308th Street. This option consists of installing a new outlet at the north end of Easter Lake to supplement the existing privately owned and problematic lake outlet channel. The new outlet would consist of a weir control structure with a pipe to carry high flows from the lake along S 308th Street and tie into the trunk line at 10th Avenue South. The existing outlet channel would remain to carry low flow from the lake. Drainage improvements would be constructed along S. 308th Street to alleviate the existing flooding problem and carry high flows from Easter Lake.

The City has updated subbasin boundary information since the development of the Tetra Tech/KCM study in 1996 and the reanalysis by MGS in 2003. The newer subbasin information revealed that approximately 21 acres of urban area located east of Pacific Highway South were not included in the Easter Lake subbasin in the previous analyses. This additional 21 acres represents approximately a 27% increase in the Easter Lake subbasin area.

The purpose of this analysis is to update the HSPF model developed by MGS in 2003, include several new analysis points, and compute discharge magnitude-frequency estimates at locations specified by the City.

PROPOSED EASTER LAKE OUTLET AND DOWNSTREAM CONVEYANCE MODIFICATIONS

The City of Federal Way is proposing a new outlet at the north end of Easter Lake. The outlet consists of a sharp crested weir control structure and approximately 200 feet of storm drain pipe to carry flow from the lake to S. 308th Street. A storm drain line will be constructed along S. 308th Street to carry flow from Easter Lake and the depression area north of the lake to the trunk line in 10th Ave South. A preliminary schematic of the proposed improvements is shown in Figure 1.



Analysis of 10th Ave. South & S.308th Street Stormwater Trunk Replacement Project

LEGEND

- Staticlk.shp
- Oldbasin.shp
- Newbasin.shp
- Floodlk.shp
- Parcels

City of Federal Way, Public Works
Contact: Jeff Wolf. P.E. (253) 835-2753

N

20 0 20 40 60 80 Feet

Map Printed-Oct 29, 2007

Figure 1

FLOOD ROUTING FOR PROPOSED EASTER LAKE OUTLET

The proposed outlet consists of a sharp crested weir with end contractions and a crest elevation of 427.9 feet. MGS was tasked with determining the weir crest length that would produce a 100-year recurrence interval lake level not to exceed 429.7 feet. The storm pipeline downstream of the weir will be designed such that it will not influence the discharge capacity of the weir up through the 100-year flood recurrence interval. The routing was performed assuming that the current outlet channel is blocked with all flow discharging through the proposed high flow weir. The final weir geometry determined from the hydrologic simulations is shown in Table 1 and the hydraulic rating table for Easter Lake used in the simulations is shown in Table 2. It is recommended that measures be included in the design to limit the potential for debris blockage in the weir structure. In addition, an emergency overflow weir should be included to pass the 100-year discharge from the lake in the event that the 2-foot wide weir opening becomes blocked with debris.

Table 1 – Proposed Easter Lake High Flow Weir Geometry

Weir Crest Elevation	427.90 feet
Crest Length	2.0 feet
Simulated 100-Year Water Surface Elevation	429.25 feet

Table 2 – Proposed Easter Lake Hydraulic Rating Table used in Hydrologic Analysis

Crest Elev (ft)	427.90
Weir Coeff	3.1
Length (ft)	2.0

Elevation (ft)	Top Area (ac)	Volume (ac-ft)	Weir Head (ft)	End Contract Effective Weir Length (ft)	Weir Discharge (cfs)
420.000	0.00	0.00	0	2.00	0.00
425.000	10.00	100.00	0	2.00	0.00
427.000	10.00	120.00	0	2.00	0.00
427.700	11.24	127.43	0	2.00	0.00
427.900	11.39	129.69	0	2.00	0.00
428.400	11.78	135.49	0.5	1.90	2.1
428.800	12.08	140.26	0.9	1.82	4.8
429.000	12.24	142.69	1.1	1.78	6.4
429.500	12.62	148.90	1.6	1.68	11
429.700	12.77	151.44	1.8	1.64	12
430.000	13.00	155.31	2.1	1.60	15
430.500	13.39	161.91	2.6	1.60	21
431.530	13.54	175.77	3.63	1.60	34

SUBBASIN BOUNDARY CHANGES

The City has updated subbasin boundary information since the development of the original HSPF model in 2003. Approximately 21 acres of urban area located east of Pacific Highway South were found to discharge to Easter Lake. In addition, the boundaries of Subbasins C5, C7, and C8 were also adjusted. Subbasin C6 was divided to isolate the discharge entering the trunk line along 10th Avenue South. Figure 2a shows a comparison of the subbasin boundaries used in the original HSPF analysis with the revised subbasin boundaries used in this analysis. Figure 2b shows the final subbasins for the Cold Creek Watershed.

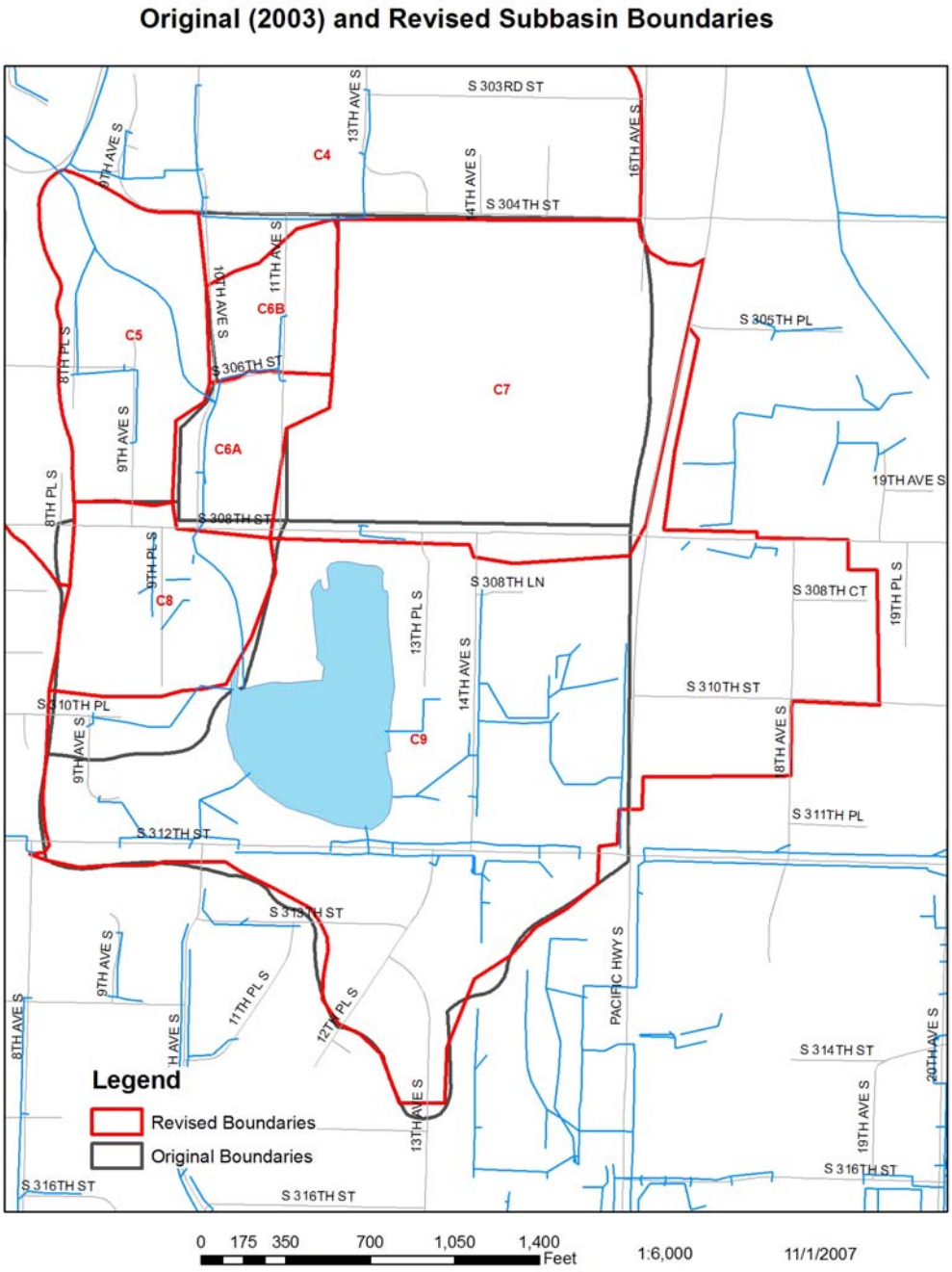


Figure 2a –Subbasin Boundary Revisions

Revised Subbasin Boundaries

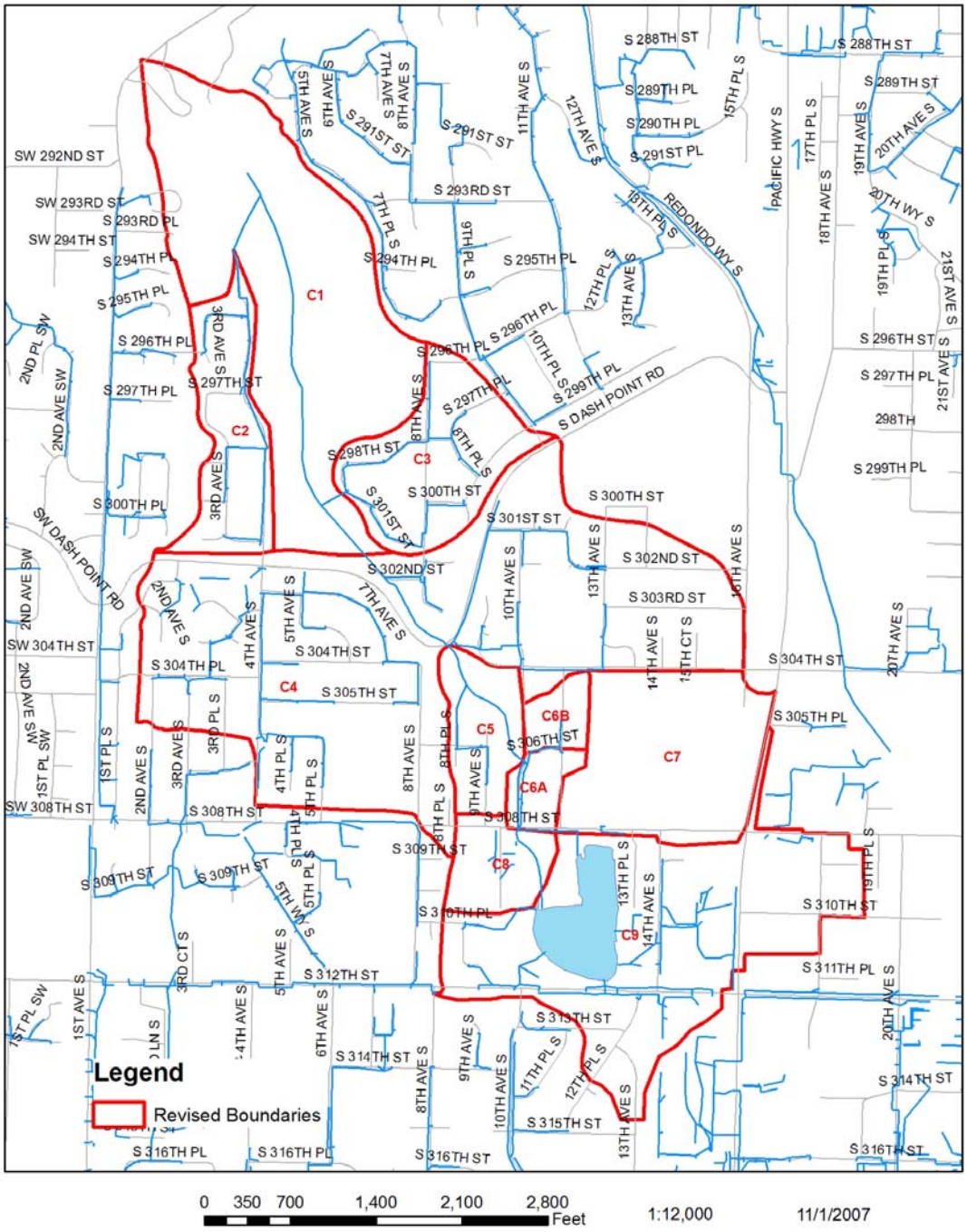


Figure 2b – Final Subbasin Boundaries used in Hydrologic Model

FLOOD FREQUENCY RESULTS FOR PROPOSED EASTER LAKE HIGH FLOW OUTLET

The HSPF hydrologic model was used to compute magnitude-frequency statistics for the proposed Easter Lake high flow weir and outflow pipeline. The Pierce County Extended Precipitation Timeseries for Continuous Hydrologic Modeling[3] was used as input to the model for the analysis. This timeseries has a timestep of 15-minutes, is 158-years in length, and represents the rainfall characteristics of the Cold Creek watershed.

Peak flow and water surface elevation magnitude-frequency estimates were computed at locations of interest using the HSPF model (Figure 3). The annual maxima discharge rates were saved at each location from the 158-years simulated. Peak flow and elevation magnitude-frequency relationships were computed using the Gringorten[4,5] plotting position formula (Equation 1).

$$Tr = \frac{N + 0.12}{i - 0.44} \qquad (1)$$

Where: Tr is the recurrence interval of the peak flow,
i is the rank of the annual maxima peak flow ordered from highest to lowest,
N is the total number of years simulated (158 in this case).

Peak discharge and lake elevation magnitude-frequency statistics are summarized in Table 3. These results were computed with the assumption that the existing outlet channel located on the west side of the lake was blocked by debris.

Table 3 – Cold Creek Magnitude-Frequency Summary

Recurrence Interval Tr (Years)	C9 Easter Lk. Proposed Weir Outflow (cfs)	C8 Discharge (cfs)	C7+C9 Discharge (cfs)	C7+C8+C9 Discharge (cfs)	C6A+C7 +C8+C9 Discharge (cfs)	C6A+C6B +C7+C8+C9 Discharge (cfs)	Easter Lake WSEL (feet)
1.01	1.3	0.7	2.6	3.4	3.6	3.9	428.22
1.5	3.0	1.3	5.1	6.1	6.5	6.9	428.53
2	3.5	1.5	5.9	7.2	7.5	7.9	428.61
5	4.8	1.9	8.7	10.5	11.0	11.7	428.79
10	5.9	2.7	11.4	13.4	14.5	15.8	428.94
25	7.8	3.8	14.3	17.8	19.3	20.8	429.17
50	8.1	4.9	16.9	20.9	23.0	25.0	429.21
100	8.4	6.3	18.7	25.0	27.3	30.0	429.24

Hydrologic Analysis Locations

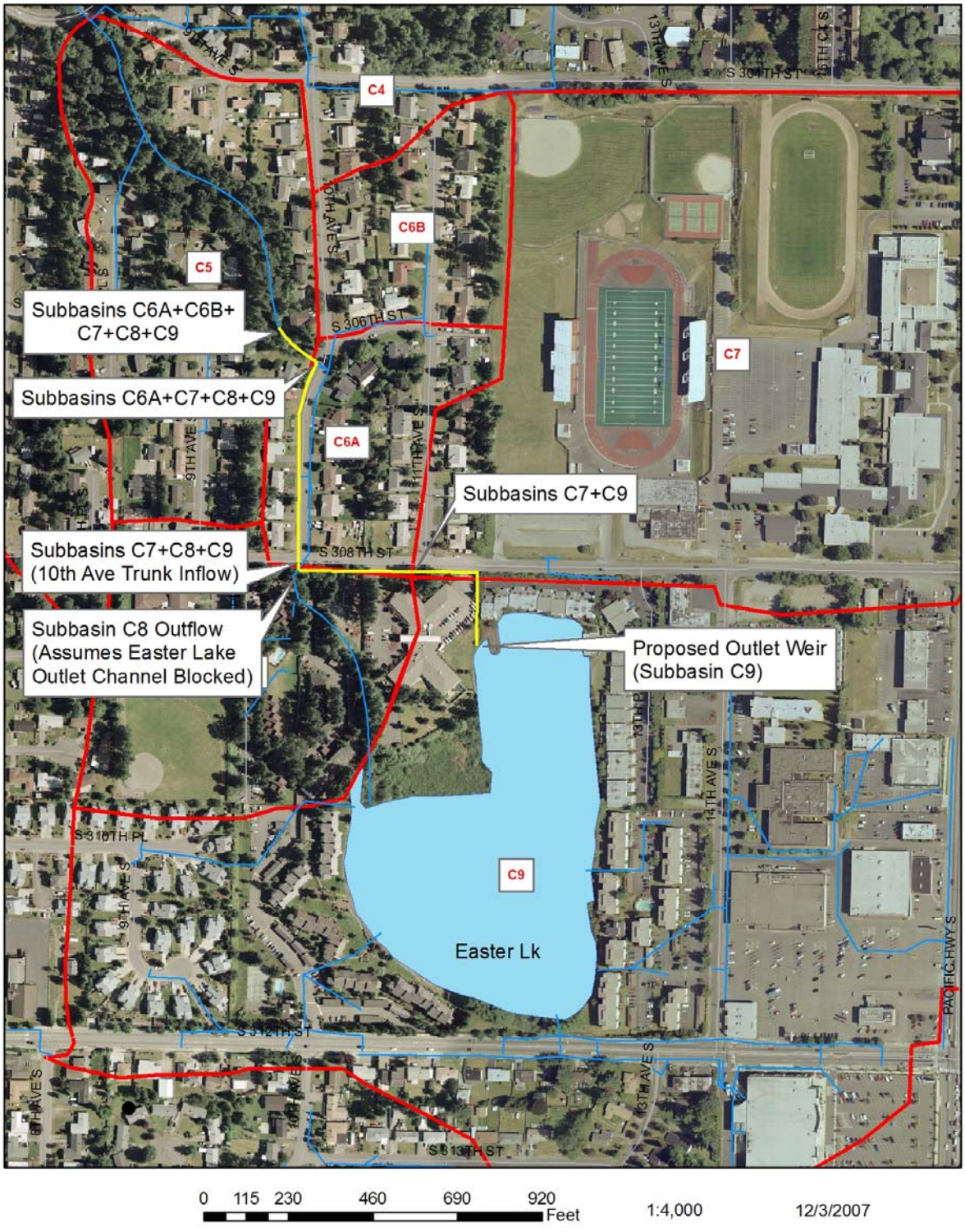


Figure 3 – Locations Where Flood Frequency Statistics Were Computed

REFERENCES

1. City of Federal Way Department of Public Works, Comprehensive Surface Water Management Plan, KCM/Tetra-Tech, May 1996

2. US Environmental Protection Agency, Hydrological Simulation Program-Fortran, Release 12, EPA Contract No. 68-C-98-010, March 2001.

3. Schaefer MG, Barker BL, Wallis JR and Nelson RN, Creation of Extended Precipitation Time-Series for Continuous Hydrological Modeling in Pierce County Washington, prepared for Pierce County Public Works by MGS Engineering Consultants Inc, Entranco, and JR Wallis, February 2001.

4. Gringorten, I. I., A Plotting Rule for Extreme Probability Paper, Journal of Geophysical Research, vol. 68, pp. 813-814, 1963.

5. Chow, Ven Te, Maidment, David R., Mays, Larry R., Applied Hydrology, pp 396, McGraw Hill, 1988.