STORMWATER SITE PLAN
FOR
THE MURRAY RESIDENCE

APRIL 19, 2021

STORMWATER SITE PLAN

FOR

THE MURRAY RESIDENCE

A portion of the Southeast Quarter of Section 13, Township 24 North, Range 4 East of the Willamette Meridian, City of Mercer Island, King County, Washington

Prepared for:

Frank Ross Murray
4803 Forest Avenue SE
Mercer Island, Washington 98040

Prepared by:

Apex Engineering PLLC
2601 South 35th, Suite 200
Tacoma, Washington 98409
(253) 473-4494
File #34578
April 19, 2021

Project Engineer: ____________________
Felix Jacobs, PE

ENGINEER'S CERTIFICATION:

"I hereby state that this Construction Stormwater Site Plan for the Murray Residence has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that the City of Mercer Island does not and will not assume liability for the sufficiency, suitability, or performance of the Construction Stormwater Site Plan prepared by me."

FELIX R. JACOBS
STATE OF WASHINGTON
42244
REGISTERED
PROFESSIONAL ENGINEER

04/20/2021

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<u>Appendices</u>

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SECTION 1 - PROJECT OVERVIEW

This stormwater site plan report provides the technical and background information for design of the stormwater facilities for the Murray Residence project. This report is intended to meet the requirements of the City of Mercer Island and the 2014 Department of Ecology Stormwater Management Manual for Western Washington (SWMMWW).

The project site is in a portion of the southeast quarter of Section 13, Township 24 North, Range 4 East, W.M., City of Mercer Island, King County, Washington. The site parcel number is 2577300021 and address is 4803 Forest Ave SE Mercer Island, WA 98040.

The existing site is approximately 0.43-acres (ac). Currently, there is an existing single-family home, driveway, garage, associated walkway, and small sheds on the parcel. There is an existing storm sewer line along the southern boundary that discharges to Lake Washington via a 12-inch CMP at the southwest corner of the site.

Development of the project consists of removing the existing house and associated driveway, walkway, and garage structure and constructing a new single-family structure with a new garage, walkway, driveway, loggia, and associated utility connections.

Runoff from the predeveloped site is collected and conveyed to Lake Washington. Runoff from the developed site will to be collected and conveyed to the existing conveyance system and then to Lake Washington. Existing drainage patterns are to remain, and no new drainage patterns are proposed. Bypass flows are not proposed.

The existing conveyance begins at the eastern property line, continues westerly, along the south property line, and continues to Lake Washington.

See Appendix A for Vicinity Map.

1.1 - Minimum Requirements

The project is required to meet All Minimum Requirements for the new and replaced hard surfaces and the land disturbed (see Appendix B). The minimum requirements are listed below with a short narrative of how each is being met.

1. *Minimum Requirement #1: Preparation of Stormwater Site Plans:*

   Preparation of this stormwater site plan is intended to meet Minimum Requirement #1.

2. *Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPPP):*

   Preparation of a construction SWPPP is intended to meet Minimum Requirement #2.

3. *Minimum Requirement #3: Source Control of Pollution:*

   The project will implement measures to prevent stormwater from encountering pollutants, including silt fence and inlet protection. See SWPPP for details.

4. *Minimum Requirement: #4: Preservation of Natural Drainage Systems and Outfalls:*

   Existing drainage patterns are utilized and no new drainage patterns are proposed.

5. *Minimum Requirement: #5: On-Site Stormwater Management*

   The project is flow control exempt and is not required to achieve the LID performance standard nor consider bioretention, rain gardens, permeable pavement, and full dispersion. Per the City of Mercer Island LID feasibility map, infiltration is not feasible on-site. See Appendix B for details.

6. *Minimum Requirement: #6: Runoff Treatment:*

   The only PGIS proposed for the site is a 3,281-sf driveway, which is less than the 5,000-sf threshold requirement treatment, so runoff treatment is not required.

7. *Minimum Requirement: #7: Flow Control:*

   The site drains to flow control exempt waters (Lake Washington).

8. *Minimum Requirement: #8: Wetlands Protection:*

   There are no known wetlands on-site or downstream of the site.

9. *Minimum Requirement: #9: Operation and Maintenance:*

   Preparation of an Operation and Maintenance manual is intended to meet Minimum Requirement #9.

SECTION 2 – EXISTING CONDITIONS SUMMARY

The existing conditions consist of:

- Single family residence home
- A garage structure
- Concrete driveway
- Landscaping
- Storm sewer line along the southern property line

The project site generally slopes moderately to steep down towards the west with an average slope of approximately 21-percent. There is a portion of steeper slope at the western portion of the site of about 32-percent.

The existing conveyance begins near the south eastern boundary and flows westerly through a series of pipes where it outlets into Lake Washington. See Section 1 for details.

The project site is situated in the City of Mercer Island's Storm Drainage Basin 25A. Refer to Section 4, Part A for details regarding the existing site hydrology.

On-site soils consist of Kitsap silt loam, per the NRCS web soil survey (see Appendix D). Table III-2.3.1 of the 2014 SWMMWW classifies the Kitsap soil type as hydrologic soil group C.

Per the City of Mercer Island's GIS information, the project site is located within a Wind Exposure 'C' with a Wind Speed-Up Factor of 1.0. All or portions of the site are also within potential slide, seismic, and erosion hazard areas. Steep slope hazard areas are identified off-site to the north, south and east. Per King County's GIS information, the project site is within the Tacoma Smelter Plume and has been identified as having lead and arsenic levels up to 40-ppm. No additional critical conditions, difficult site parameters or flood plains are known to exist at this time.

The City of Mercer Island recently determined that a watercourse does not exist in the southern portion of the Murray property, but there may be a wetland present in that vicinity. Currently, outlet flow from an existing lined pond in the adjacent parcel east of the site is conveyed in a pipe system on the Murray property, meanders to the southwest and into the adjacent parcel for approximately 110-feet, crosses back into the Murray property, and is then conveyed to the shore.

SECTION 3 – OFF-SITE ANALYSIS

This project does not propose to add 5,000-sf or more of new hard surface. Therefore, per Section 3.1.3 of the SWMMWW, an off-site analysis should not be required for the project. Additionally, the stormwater runoff from the site is proposed to directly discharge through approximately 200-ft of pipes into Lake Washington and should have a minimal adverse impact to the downstream system. All existing drainage patterns are proposed to be maintained.

SECTION 4 – PERMANENT STORMWATER CONTROL PLAN

Part A - Summary

The site is currently developed and graded to slope down to the west. The stormwater run-off for the site is conveyed to an existing system along the southern boundary of the site, then discharges through a 12-inch storm pipe to Lake Washington. The existing system was verified for conveyance capacity from the adjacent parcel east of the project.

The following table summarizes the pre-developed and developed site conditions:

	Land Use	Acreage	Soil Group
PRE	Pervious (lawn, landscape)	0.32	C
	Impervious	0.14	C
	Total	**0.46**	C
DEV	Pervious (lawn, landscape)	0.26	C
	Impervious	0.20	C
	Total	**0.46**	C

The effective impervious surfaces in the pre-developed conditions consist of the house and its associated driveway, walkways, and garage are approximately 0.14-ac in size. The effective impervious surfaces in the developed conditions consist of the new residence and its associated driveway, walkways, loggia, and garage and are approximately 0.20-ac in size.

Part B - Performance Standards and Goals

The storm system is to conform to the City of Mercer Island and 2014 SWMMWW standards.

Runoff treatment is not required since the project creates less than the 5,000-sf threshold requiring treatment.

Flow control is not required. The project discharges stormwater to Lake Washington, which is a Flow Control Exempt Receiving Water.

The proposed conveyance system is modeled and has been verified to have capacity sufficient to contain the 100-year storm event (SBUH Methodology). Refer to Section 4, Part F for further information.

Part C – Low Impact Development Features

As shown by the WWHM results included in Appendix C, this project meets the LID performance standard. Therefore, the project is not required to implement items from List #1 of the City of Mercer Island's Small Project Stormwater Requirements. Furthermore, per the City of Mercer Island's Infiltration Feasibility Map included in Appendix C, the site is located in an area where infiltrating LID facilities are not permitted.

Part D – Flow Control System

Not required. The project discharges to Lake Washington, which is a flow control exempt receiving water.

Part E – Water Quality System

Not required. The project creates less than the 5,000-sf of pollution generating impervious surface threshold requiring treatment.

Part F – Conveyance System Analysis and Design

Refer to Appendix C for engineering calculations.

Runoff from the proposed 3,640-sf roof area and 5,230-sf associated improvements (drive, walk, and loggia) is proposed to be conveyed into the existing 6-inch private storm system south of the proposed residence via 4-inch roof drains and 6-inch storm drain lines. The private storm system conveys runoff through an existing catchbasin to the south of the site, where it continues to the west for approximately 200-ft through 8- and 12-inch pipe that outlets into Lake Washington.

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The conveyance system was analyzed using StormShed 2G software and Flowmaster software, using Manning's Equation, and the SBUH Method. A Manning's roughness coefficient (n) of 0.014 and precipitation values as shown in Isopluvial Maps from the 2014 ECY SWMMWW were used.

StormShed 2G was used to model the site as impervious surface as a factor of safety to ensure the storm system can adequately convey the proposed improvements, although the project is proposing only 0.20-ac. of impervious area. The peak flow from the StormShed analysis is 0.4206-cfs from the 100-year storm.

The minimum pipe slope for the on-site conveyance system is 2.33-percent. A 2.0-percent slope was assumed for the conveyance analysis, as a factor of safety. Flowmaster results show that a 6-inch (0.5-ft) diameter pipe at a minimum slope of 2.0-percent and a discharge of 0.4206-cfs, would have a flow depth of 0.27-ft. Therefore, the proposed conveyance system should adequately handle stormwater runoff from the proposed rooftop area.

The existing 12-inch stormwater pipe that discharges stormwater from the site has a slope of 28-percent. The pipe is able to convey 17.51-cfs with a manning's roughness coefficient of 0.014, according to Flowmaster calculations. The proposed project (0.46-ac.) and run-on from existing upstream areas (2.56-ac) totals 3.02-ac. and creates a peak flow of 2.76-cfs, per StormShed calculations. The existing 12-inch stormwater pipe will be able to convey runoff adequately. See Appendix C for detailed calculations.

SECTION 5 – CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

See the associated SWPPP for the project. The project has considered the 13 Elements of Construction Stormwater Pollution outlined in the 2014 ECY SWMMWW.

SECTION 6 – SPECIAL REPORTS AND STUDIES

An NRCS Soil Report was obtained for the site and is included in Appendix D.

SECTION 7 – OTHER PERMITS

Anticipated permits:

- Building permits

SECTION 8 – OPERATION AND MAINTENANCE MANUAL

See the associated Operation and Maintenance (O&M) Manual for the project.

SECTION 9 – DECLARATION OF COVENANT FOR PRIVATELY MAINTAINED FLOW CONTROL AND TREATMENT FACILITIES

Not applicable.

SECTION 10 – DECLARATION OF COVENANT FOR PRIVATELY MAINTAINED ON-SITE STORMWATER MANAGEMENT BMPs

The onsite storm drainage system will be privately maintained by the property owner after acceptance of the improvements.

SECTION 11 – BOND QUANTITIES WORKSHEET

To be provided upon request.

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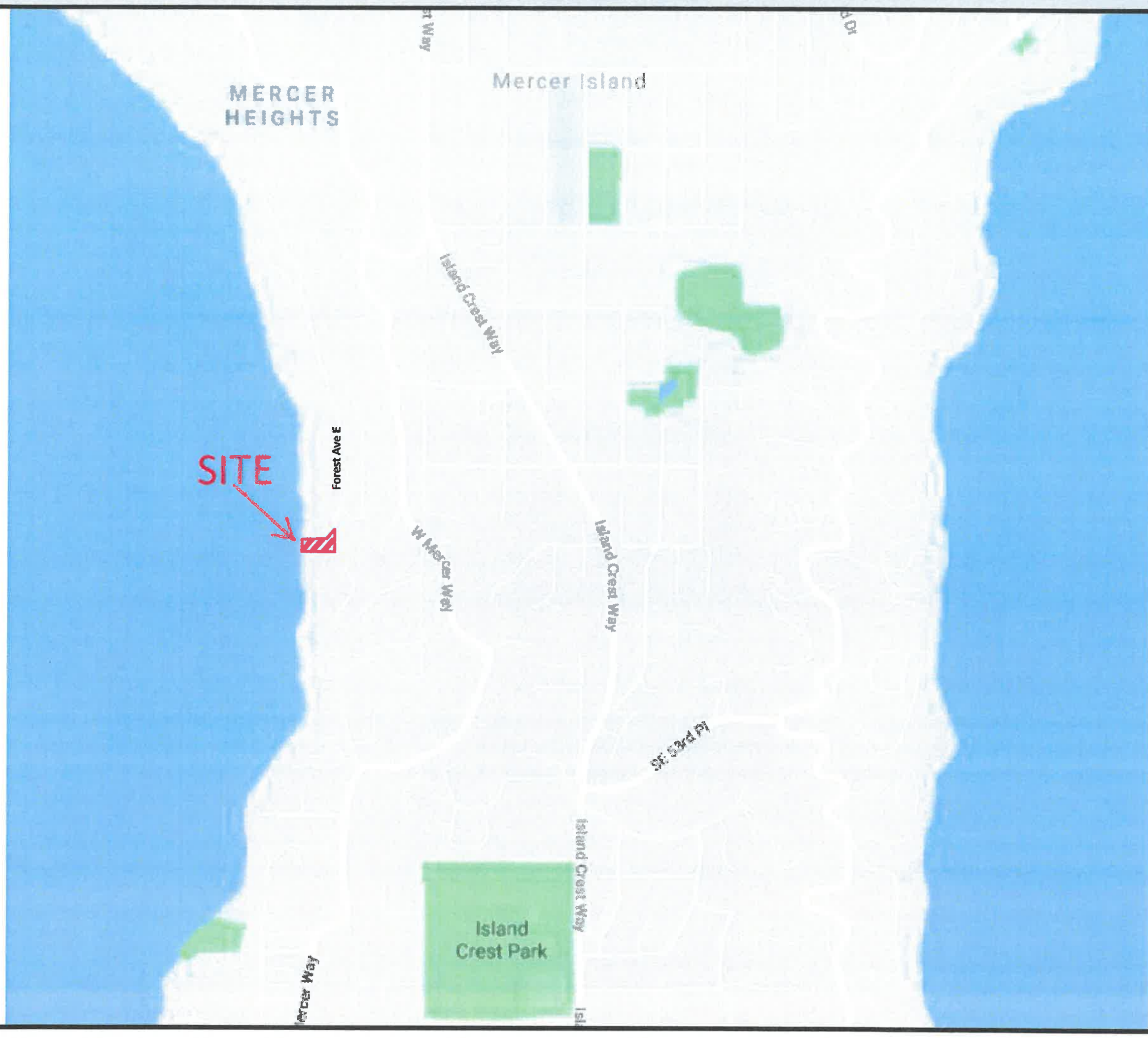
Appendix A

Vicinity Map

MURRAY RESIDENCE

VICINITY MAP

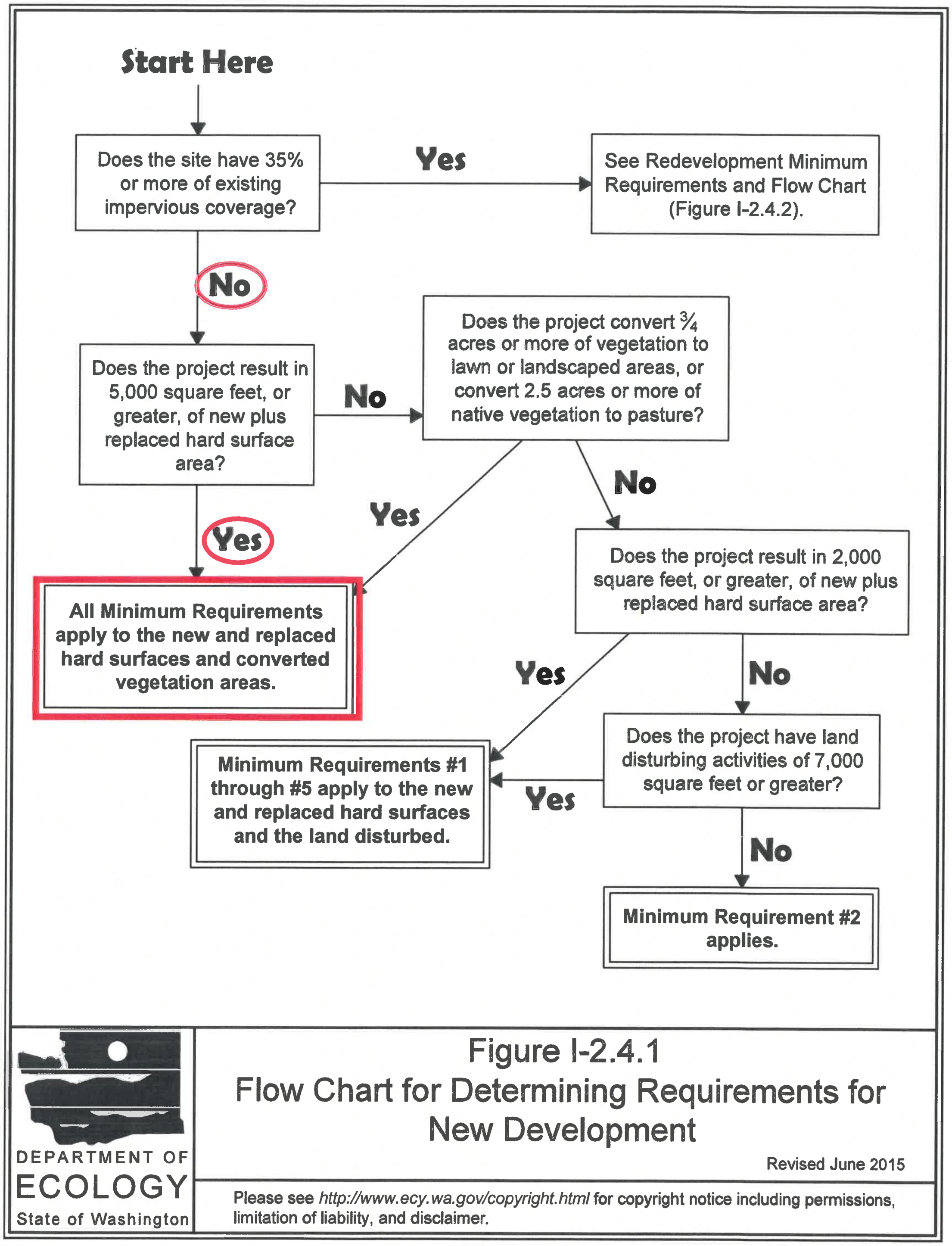
N.T.S



Appendix B

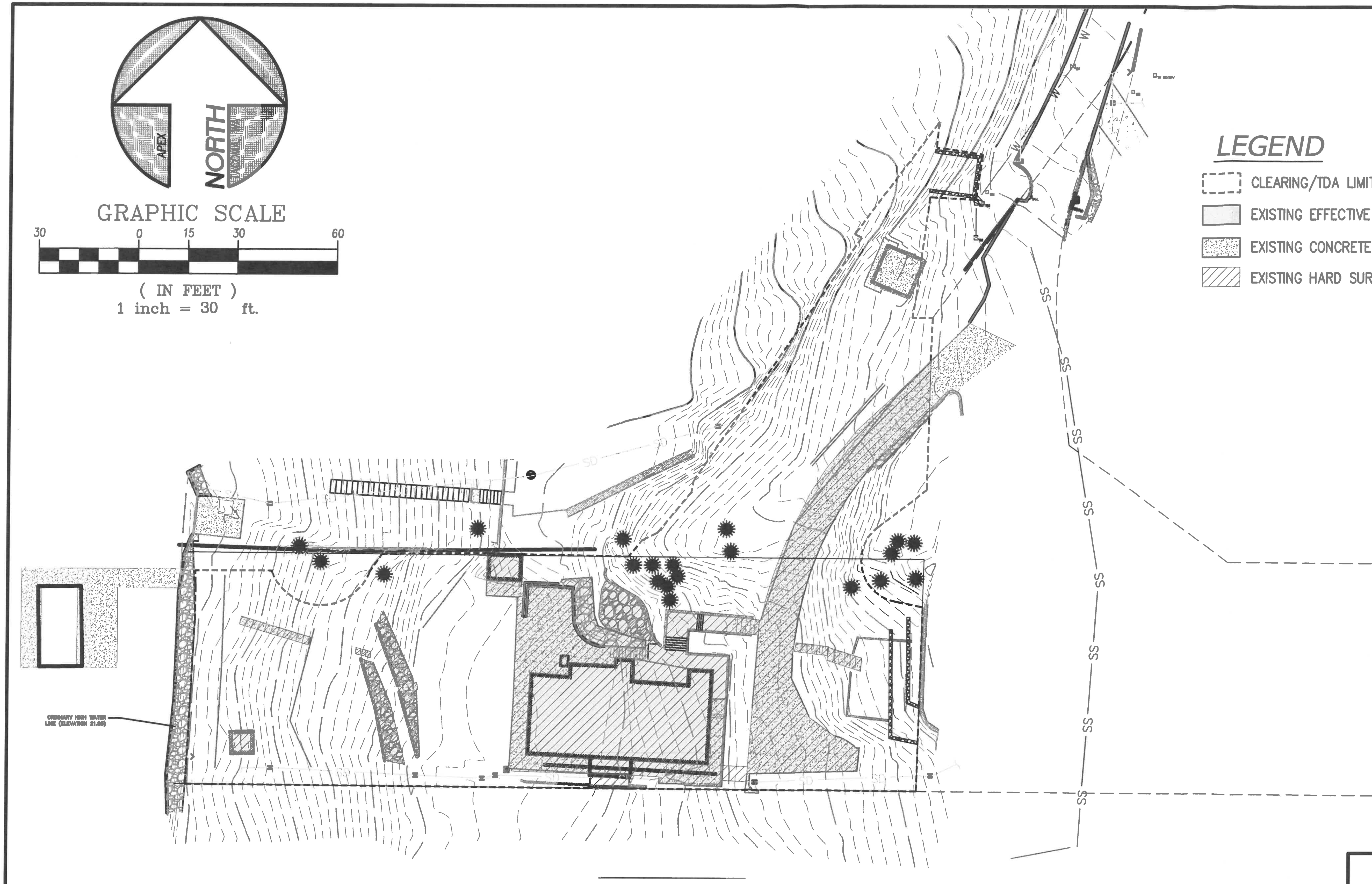
Minimum Requirement Flow Charts

Figure I-2.4.1 Flow Chart for Determining Requirements for New Development



Appendix C

Engineering Calculations



LEGEND

- CLEARING/TDA LIMITS (0.46± AC)
- EXISTING EFFECTIVE IMPERVIOUS SURFACE (0.14± ACRES)
- EXISTING CONCRETE DRIVEWAY/SIDEWALK
- EXISTING HARD SURFACE TO BE REMOVED

PRE-DEVELOPED TDA MAP

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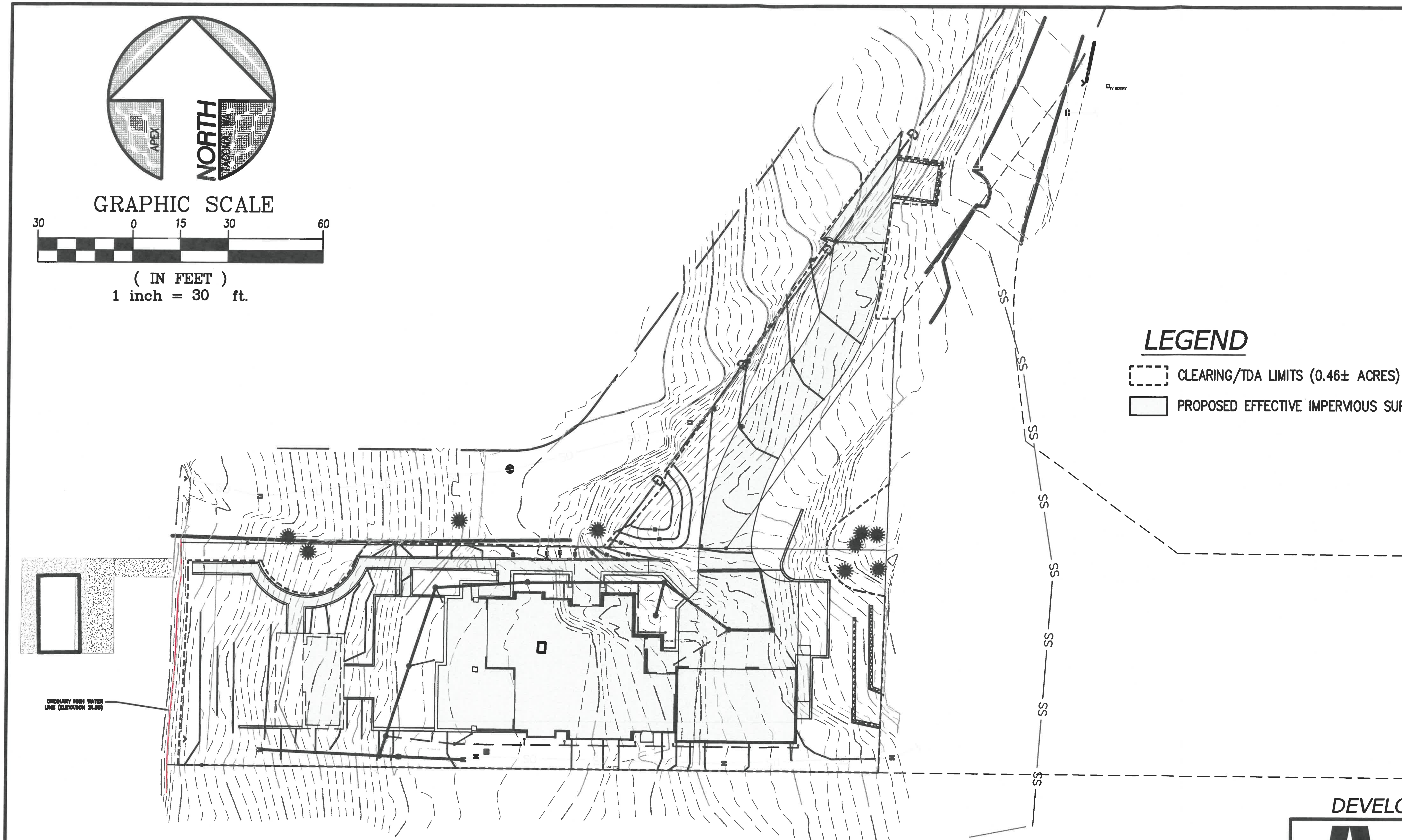
GRAPHIC SCALE

30 0 15 30 60

(IN FEET)
1 inch = 30 ft.



LEGEND

CLEARING/TDA LIMITS (0.46± ACRES)

PROPOSED EFFECTIVE IMPERVIOUS SURFACE (0.20± ACRES)

DEVELOPED TDA MAP

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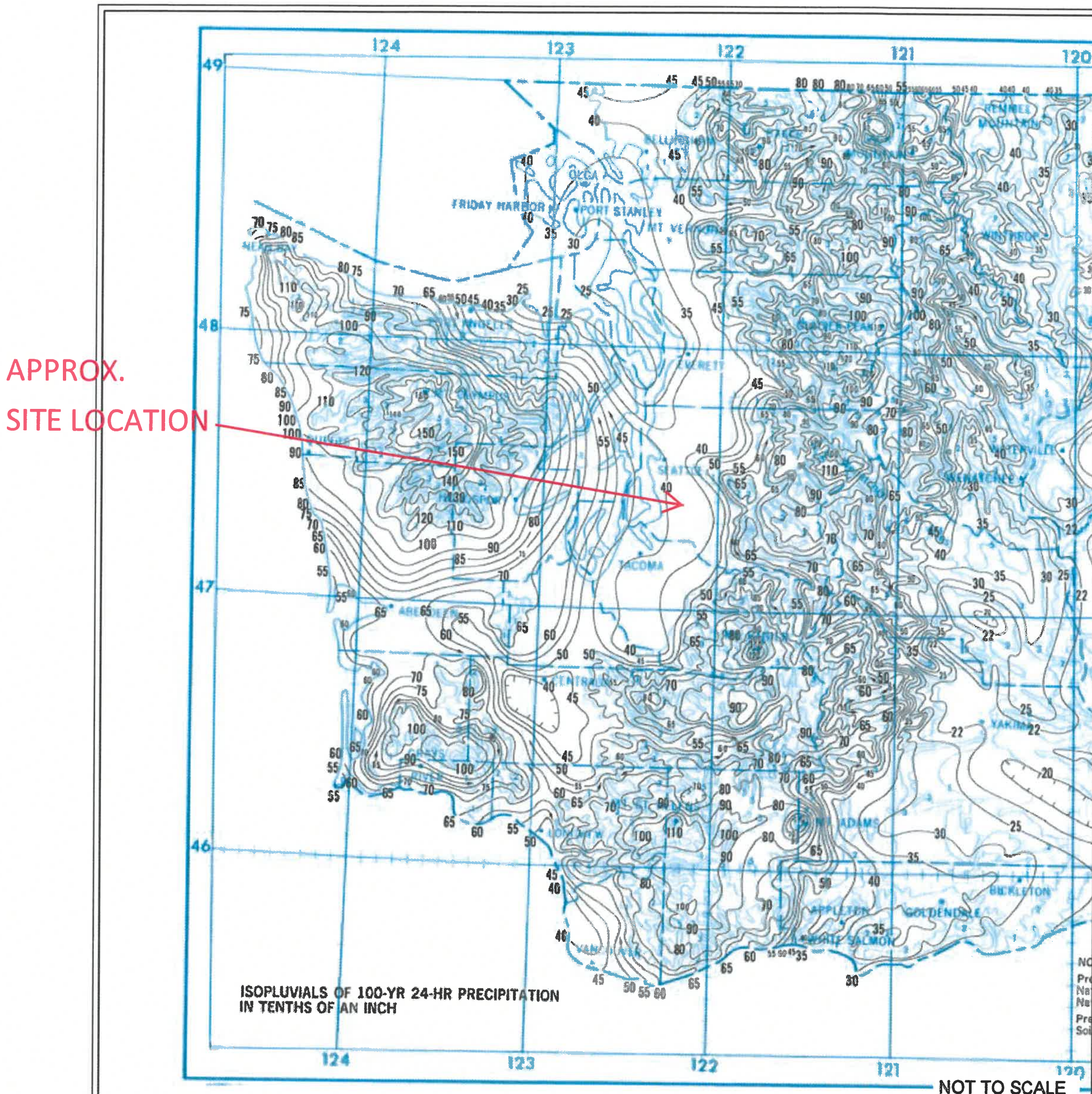
Figure III-A.3 Western Washington Isopluvial 100-year, 24 hour



DEPARTMENT OF
ECOLOGY
State of Washington

Figure III-A.3
Western Washington Isopluvial
100-year, 24 hour

Revised January 2016

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	34578_TDA_041921
Site Name:	Murray
Site Address:	4803 Forest
City:	Mercer Isl.
Report Date:	4/20/2021
Gage:	Seatac
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data
Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Steep	0.32
Pervious Total	0.32
Impervious Land Use	acre
DRIVEWAYS FLAT	0.14
Impervious Total	0.14
Basin Total	0.46

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Steep	0.26
Pervious Total	0.26
Impervious Land Use	acre
DRIVEWAYS FLAT	0.2
Impervious Total	0.2
Basin Total	0.46

Element Flows To:

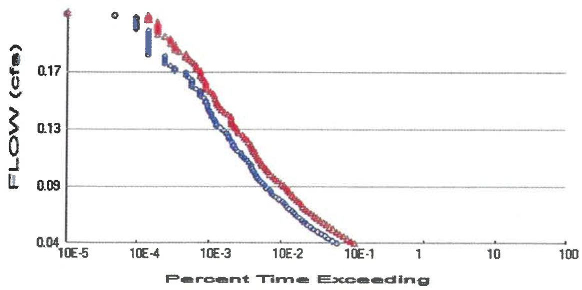
Surface	Interflow	Groundwater

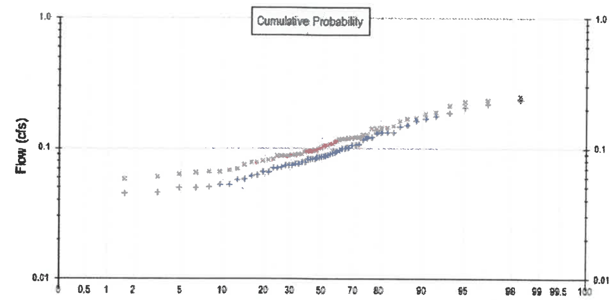
Routing Elements
Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.32
Total Impervious Area: 0.14

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.26
Total Impervious Area: 0.2

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.088373
5 year	0.1259
10 year	0.152678
25 year	0.188667
50 year	0.217031
100 year	0.246722

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.103787
5 year	0.141752
10 year	0.168567
25 year	0.204393
50 year	0.232517
100 year	0.261889

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.146	0.161
1950	0.131	0.142
1951	0.083	0.094
1952	0.052	0.063
1953	0.050	0.066
1954	0.074	0.087
1955	0.074	0.090
1956	0.071	0.087
1957	0.101	0.116
1958	0.062	0.078

1959	0.050	0.066
1960	0.089	0.099
1961	0.076	0.090
1962	0.053	0.068
1963	0.083	0.096
1964	0.066	0.080
1965	0.106	0.121
1966	0.058	0.069
1967	0.132	0.142
1968	0.120	0.143
1969	0.100	0.113
1970	0.086	0.101
1971	0.099	0.117
1972	0.131	0.144
1973	0.049	0.061
1974	0.096	0.112
1975	0.106	0.120
1976	0.076	0.087
1977	0.071	0.082
1978	0.083	0.097
1979	0.090	0.120
1980	0.161	0.171
1981	0.088	0.106
1982	0.150	0.168
1983	0.085	0.109
1984	0.061	0.075
1985	0.086	0.104
1986	0.085	0.097
1987	0.093	0.121
1988	0.045	0.065
1989	0.057	0.081
1990	0.237	0.251
1991	0.175	0.189
1992	0.066	0.078
1993	0.045	0.058
1994	0.039	0.054
1995	0.072	0.089
1996	0.121	0.127
1997	0.091	0.105
1998	0.078	0.089
1999	0.206	0.232
2000	0.094	0.109
2001	0.073	0.095
2002	0.130	0.147
2003	0.117	0.127
2004	0.186	0.212
2005	0.083	0.095
2006	0.078	0.088
2007	0.215	0.227
2008	0.169	0.183
2009	0.105	0.117

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.2370	0.2512
2	0.2155	0.2323
3	0.2055	0.2268

4	0.1859	0.2121
5	0.1746	0.1887
6	0.1688	0.1832
7	0.1614	0.1714
8	0.1497	0.1678
9	0.1463	0.1614
10	0.1322	0.1469
11	0.1314	0.1445
12	0.1314	0.1429
13	0.1295	0.1424
14	0.1211	0.1421
15	0.1196	0.1273
16	0.1169	0.1273
17	0.1062	0.1212
18	0.1058	0.1211
19	0.1055	0.1202
20	0.1005	0.1198
21	0.0996	0.1175
22	0.0994	0.1173
23	0.0965	0.1155
24	0.0938	0.1127
25	0.0928	0.1117
26	0.0909	0.1087
27	0.0903	0.1086
28	0.0887	0.1058
29	0.0879	0.1053
30	0.0861	0.1042
31	0.0860	0.1005
32	0.0853	0.0994
33	0.0851	0.0971
34	0.0831	0.0966
35	0.0829	0.0955
36	0.0828	0.0954
37	0.0825	0.0950
38	0.0778	0.0939
39	0.0775	0.0905
40	0.0758	0.0901
41	0.0755	0.0888
42	0.0741	0.0887
43	0.0736	0.0877
44	0.0735	0.0872
45	0.0717	0.0872
46	0.0711	0.0869
47	0.0708	0.0825
48	0.0662	0.0814
49	0.0655	0.0804
50	0.0622	0.0779
51	0.0614	0.0779
52	0.0579	0.0748
53	0.0574	0.0693
54	0.0526	0.0679
55	0.0524	0.0659
56	0.0503	0.0658
57	0.0497	0.0646
58	0.0492	0.0634
59	0.0453	0.0607
60	0.0451	0.0579
61	0.0393	0.0539

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0442	1334	2340	175	Fail
0.0459	1168	2085	178	Fail
0.0477	1011	1859	183	Fail
0.0494	898	1645	183	Fail
0.0512	804	1459	181	Fail
0.0529	713	1318	184	Fail
0.0547	621	1182	190	Fail
0.0564	566	1051	185	Fail
0.0582	510	944	185	Fail
0.0599	462	864	187	Fail
0.0616	431	772	179	Fail
0.0634	394	697	176	Fail
0.0651	359	637	177	Fail
0.0669	331	574	173	Fail
0.0686	310	518	167	Fail
0.0704	283	475	167	Fail
0.0721	257	439	170	Fail
0.0739	244	423	173	Fail
0.0756	228	389	170	Fail
0.0774	207	358	172	Fail
0.0791	184	330	179	Fail
0.0809	168	311	185	Fail
0.0826	159	289	181	Fail
0.0843	149	274	183	Fail
0.0861	137	259	189	Fail
0.0878	129	236	182	Fail
0.0896	120	219	182	Fail
0.0913	111	196	176	Fail
0.0931	104	181	174	Fail
0.0948	99	168	169	Fail
0.0966	95	154	162	Fail
0.0983	90	144	160	Fail
0.1001	86	137	159	Fail
0.1018	84	131	155	Fail
0.1035	83	120	144	Fail
0.1053	78	115	147	Fail
0.1070	72	108	150	Fail
0.1088	67	104	155	Fail
0.1105	62	100	161	Fail
0.1123	60	97	161	Fail
0.1140	54	91	168	Fail
0.1158	49	88	179	Fail
0.1175	47	85	180	Fail
0.1193	46	82	178	Fail
0.1210	44	76	172	Fail
0.1228	41	72	175	Fail
0.1245	40	66	165	Fail
0.1262	39	63	161	Fail
0.1280	37	55	148	Fail
0.1297	34	53	155	Fail
0.1315	31	51	164	Fail
0.1332	27	48	177	Fail
0.1350	27	44	162	Fail
0.1367	26	43	165	Fail

0.1385	25	43	172	Fail
0.1402	23	43	186	Fail
0.1420	23	39	169	Fail
0.1437	22	35	159	Fail
0.1454	21	32	152	Fail
0.1472	20	30	150	Fail
0.1489	20	28	140	Fail
0.1507	19	27	142	Fail
0.1524	19	27	142	Fail
0.1542	18	26	144	Fail
0.1559	16	25	156	Fail
0.1577	16	24	150	Fail
0.1594	16	22	137	Fail
0.1612	14	20	142	Fail
0.1629	12	19	158	Fail
0.1647	12	19	158	Fail
0.1664	12	19	158	Fail
0.1681	12	18	150	Fail
0.1699	11	17	154	Fail
0.1716	10	16	160	Fail
0.1734	10	16	160	Fail
0.1751	7	16	228	Fail
0.1769	7	14	200	Fail
0.1786	6	14	233	Fail
0.1804	5	13	260	Fail
0.1821	5	12	240	Fail
0.1839	5	11	220	Fail
0.1856	5	10	200	Fail
0.1874	3	10	333	Fail
0.1891	3	8	266	Fail
0.1908	3	7	233	Fail
0.1926	3	7	233	Fail
0.1943	3	7	233	Fail
0.1961	3	6	200	Fail
0.1978	3	6	200	Fail
0.1996	3	6	200	Fail
0.2013	3	5	166	Fail
0.2031	3	4	133	Fail
0.2048	3	4	133	Fail
0.2066	2	4	200	Fail
0.2083	2	4	200	Fail
0.2100	2	4	200	Fail
0.2118	2	4	200	Fail
0.2135	2	3	150	Fail
0.2153	2	3	150	Fail
0.2170	1	3	300	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic

Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME      0 RUN      1                 UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   34578_TDA_041921.wdm
MESSU      25   Pre34578_TDA_041921.MES
           27   Pre34578_TDA_041921.L61
           28   Pre34578_TDA_041921.L62
           30   POC34578_TDA_0419211.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      18
      IMPLND       5
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                    MAX                   1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out            ***
   18      C, Lawn, Steep          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   18         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   18         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   18       0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   18            0         4.5      0.03       400      0.15       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   18            0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   18            0.1      0.15      0.25         6       0.3      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   18            0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------> Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
    5      DRIVEWAYS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    5         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   *********
    5         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI    ***
    5         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    5            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    5              0         0
```

```
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    5            0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK    ***
<Name>   #                  <-factor->     <Name>   #   Tbl#    ***
Basin  1***
PERLND  18                        0.32     COPY   501     12
PERLND  18                        0.32     COPY   501     13
IMPLND   5                        0.14     COPY   501     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG             ***
                                         in  out                             ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # - #    FTABNO       LEN      DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
           *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
```

```
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN      1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   34578_TDA_041921.wdm
MESSU      25   Mit34578_TDA_041921.MES
           27   Mit34578_TDA_041921.L61
           28   Mit34578_TDA_041921.L62
           30   POC34578_TDA_0419211.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      18
      IMPLND       5
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1   PYR DIG2 FIL2 YRND
    1        Basin  1                     MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                           User  t-series Engl Metr ***
                                           in  out           ***
   18      C, Lawn, Steep          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   18         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   18         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   18       0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   18            0         4.5      0.03       400      0.15       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   18            0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   18            0.1      0.15      0.25         6       0.3      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   18            0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------> Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
    5      DRIVEWAYS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    5         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   *********
    5         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI    ***
    5         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    5            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    5              0         0
```

```
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    5              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  18                        0.26     COPY   501     12
PERLND  18                        0.26     COPY   501     13
IMPLND   5                        0.2      COPY   501     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                         in  out                             ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
           *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
```

```
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

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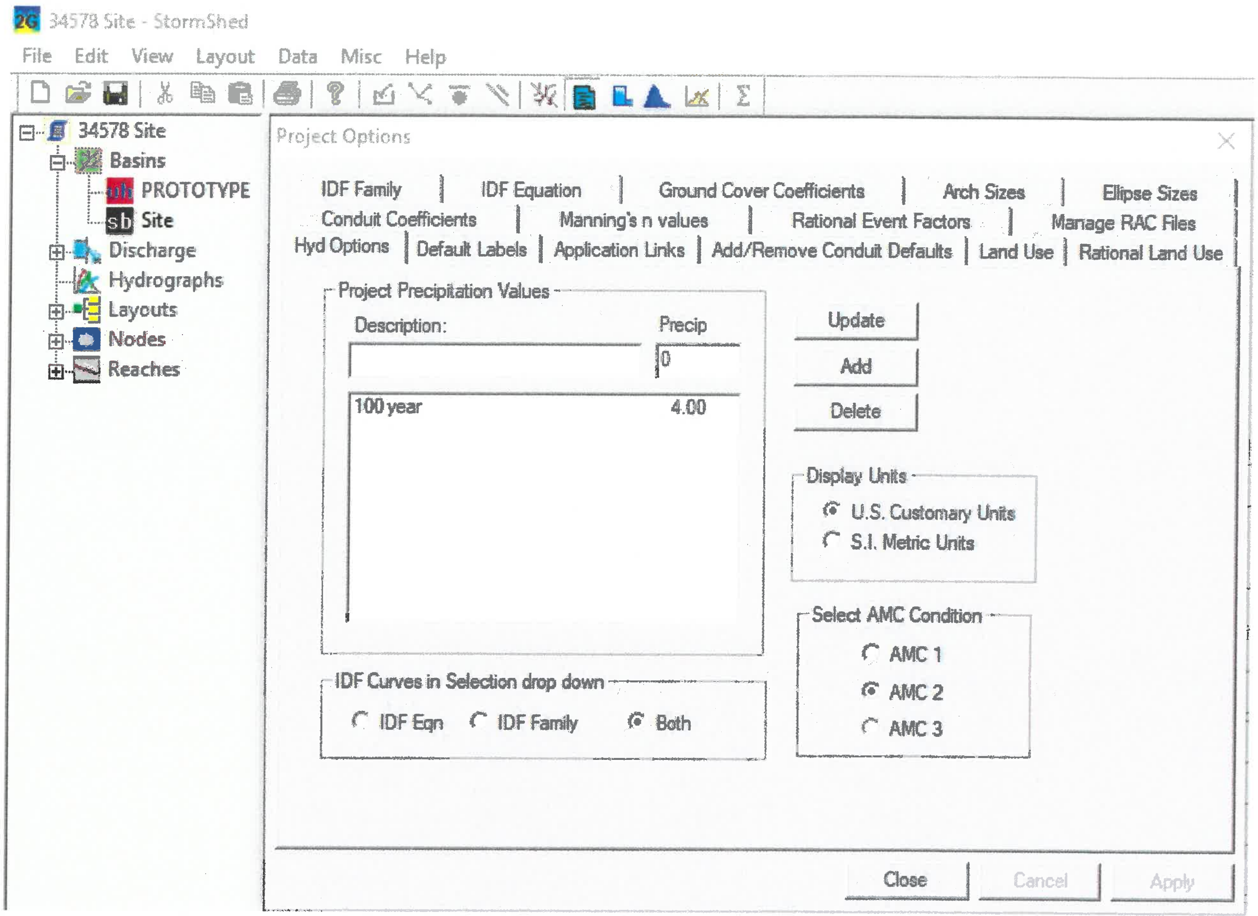
CONVEYANCE SYSTEM ANALYSIS

Murray Residence
Job #34578



Site Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
100 year	0.4206	8.00	0.1443	0.4600	SBUH	TYPE1A

Record Id: Site

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area (AMC 2)	0.00 ac	**DCIA**	0.46 ac
Pervious CN	0.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Fixed	Assumed					5.00 min

Pervious TC	5.00 min

Directly Connected CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.46 ac	98.00
DC Composited CN (AMC 2)		98.00

Directly Connected TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Fixed	Assumed					5.00 min
Directly Connected TC						5.00min

CONVEYANCE SYSTEM ANALYSIS:
Upstream Contributions and Existing 12" Pipe Capacity

Tributary Basin Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	1.3338	8.00	0.4465	3.0200	SBUH	TYPE1A
10 year	2.0508	8.00	0.6966	3.0200	SBUH	TYPE1A
100 year	2.7613	8.00	0.9475	3.0200	SBUH	TYPE1A

Record Id: Tributary Basin

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area (AMC 2)	0.00 ac	**DCIA**	3.02 ac
Pervious CN	0.00	**DC CN**	98.00
Pervious TC	0.00 min	**DC TC**	5.00 min

Directly Connected CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	3.02 ac	98.00
DC Composited CN (AMC 2)		98.00

Directly Connected TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Fixed	Assume					5.00 min
Directly Connected TC						5.00min

Haestad Method's Flowmaster 1 (Version 3.16) Results:

PIPE FLOW (MINIMUM SLOPE):

Solve For......Depth

Diameter	0.50 ft	Velocity	3.80 fps
Slope	0.0200 (ft/ft)	Flow Area	0.11 sf
Manning's n	0.014	Critical Slope	0.0109 ft/ft
Discharge	0.4206 (cfs)	Critical Depth	0.33 ft
Depth	**0.27 ft**	Percent Full	54.14 %
		Froude Number	1.46
		Full Capacity	0.74 cfs
		Q(max) @.94D	0.79 cfs

Haestad Method's Flowmaster 1 (Version 3.16) Results:

PIPE FLOW (MINIMUM SLOPE):

Solve For......Actual Discharge

Diameter	1.00 ft	Velocity	22.29 fps
Slope	0.2800 (ft/ft)	Flow Area	0.79 sf
Manning's n	0.014	Critical Slope	0.2740 ft/ft
Discharge	17.51 (cfs)	Critical Depth	1.00 ft
Depth	1.00 ft	Percent Full	100.00 %
		Froude Number	Full
		Full Capacity	17.51 cfs
		Q(max) @.94D	18.83 cfs

Appendix D

Soils Report

USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

King County Area, Washington

Murray Residence

July 31, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

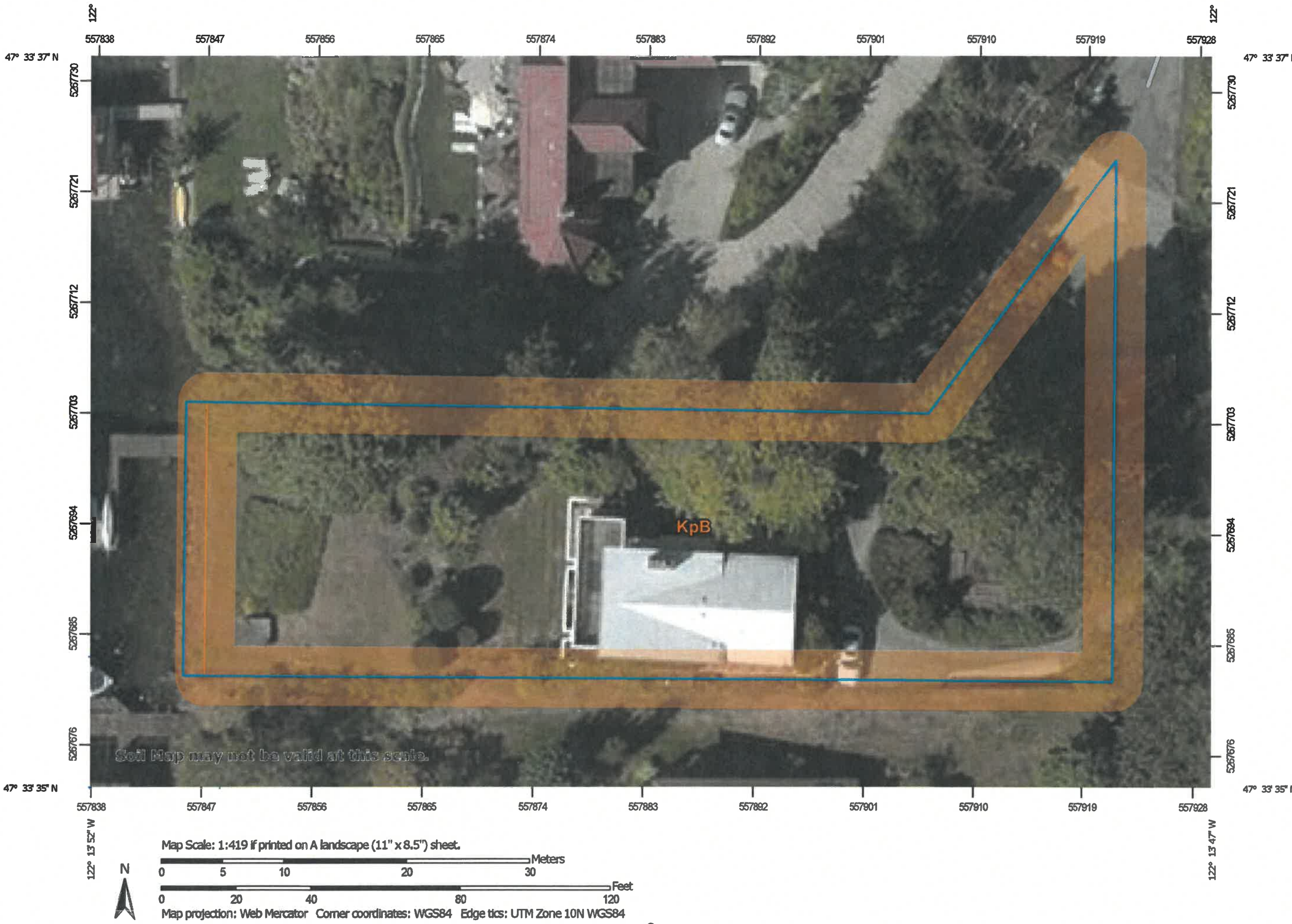
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map (Murray Residence)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: King County Area, Washington
Survey Area Data: Version 14, Sep 10, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 31, 2013—Oct 6, 2013

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend (Murray Residence)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
KpB	Kitsap silt loam, 2 to 8 percent slopes	0.4	97.9%
Totals for Area of Interest		**0.5**	**100.0%**

Map Unit Descriptions (Murray Residence)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

King County Area, Washington

KpB—Kitsap silt loam, 2 to 8 percent slopes

Map Unit Setting

National map unit symbol: 1hmt9
Elevation: 0 to 590 feet
Mean annual precipitation: 37 inches
Mean annual air temperature: 50 degrees F
Frost-free period: 160 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Kitsap and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kitsap

Setting

Landform: Terraces
Parent material: Lacustrine deposits with a minor amount of volcanic ash

Typical profile

H1 - 0 to 5 inches: silt loam
H2 - 5 to 24 inches: silt loam
H3 - 24 to 60 inches: stratified silt to silty clay loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C
Forage suitability group: Soils with Few Limitations (G002XN502WA)
Hydric soil rating: No

Minor Components

Alderwood

Percent of map unit: 10 percent
Hydric soil rating: No

Bellingham

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

Seattle

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

Tukwila

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

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