Appendix E: Capital Project Modeling Results

Table E-1. CIP Hydraulic Model Parameters and Results

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Future 10 yr CIP Max Water Surface		Future 25 yr CIP Max Water Surface		Future CIP Max Flow (cfs)		
Link ID	Length (ft)	Shape	Diameter/ Height (ft)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	10-yr	25-yr	CIP Project Number
Herman Road System																	
322603	108.8	Circular	2.0	2.2	322601_HE-0160	HE-0150	127.3	125.0	131.1	130.0	129.3	128.4	130.37	129.05	14.24	16.61	CIP #5
Link48	200.0	Circular	3.0	0.1	HE-0150	HE-0140	124.5	124.2	130.0	129.0	128.4	128.1	129.05	128.68	16.58	19.31	CIP #5
Link49	200.0	Circular	3.0	0.1	HE-0140	Node571	124.0	123.7	129.0	128.6	128.1	127.6	128.68	127.94	23.59	27.46	CIP #5
Link50	200.0	Circular	3.0	0.1	Node571	322634.0	123.5	123.2	128.6	128.2	127.6	127.0	127.94	127.20	23.59	27.46	CIP #5
Link52	200.0	Circular	3.0	0.1	HE-0120	322634.0	123.3	123.2	128.3	128.2	127.0	127.0	127.17	127.20	-5.42	-6.14	CIP #5
Link51	160.0	Circular	3.0	0.1	HE-0120	322613.0	123.3	123.2	128.3	128.2	127.0	126.9	127.17	127.09	8.68	9.99	CIP #5
Manhasset Drive System																	
267387	102.0	Circular	2.5	4.1	261974_HE-0510	262060_HE-0500	157.90	153.75	160.40	160.40	158.65	154.70	160.16	154.80	15.0	17.4	CIP #1
Link9	200.0	Circular	2.5	3.4	262060_HE-0500	Node280	153.75	147.00	160.40	153.00	154.70	147.81	154.80	147.88	16.0	18.6	CIP #1
Link12	200.0	Circular	2.5	3.2	Node280	Node283	146.80	140.40	153.00	146.40	147.70	141.47	147.78	141.60	16.0	18.6	CIP #1
Link15	200.0	Circular	2.5	1.2	Node283	HE-0490	140.20	137.90	146.40	143.40	141.47	139.17	141.60	139.37	16.0	18.6	CIP #1
Link11	350.0	Circular	2.5	0.9	HE-0490	262001	137.70	134.65	143.40	139.76	139.17	136.70	139.37	137.02	19.2	22.3	CIP #1
266696	47.4	Circular	2.5	0.6	262001	259248	134.65	134.37	139.76	139.25	136.70	136.19	137.02	136.50	19.2	22.3	CIP #1
266695	132.0	Circular	2.5	0.6	259248	262763_HE-0480	134.17	133.40	139.25	138.78	136.19	135.34	136.50	135.55	19.2	22.3	CIP #1
268265	149.3	Circular	3.0	0.1	262763_HE-0480	262764	133.20	133.00	138.78	137.99	135.34	134.47	135.55	134.59	20.9	24.3	CIP #1
268266	407.7	Circular	3.0	0.7	262764	262765_HE-0470	132.80	129.98	137.99	135.43	134.29	132.26	134.48	132.52	20.9	24.3	CIP #1
266697	194.1	Circular	3.0	0.2	262765_HE-0470	271161	129.88	129.56	135.43	132.56	132.26	131.18	132.52	131.31	25.1	29.3	CIP #1
Nyberg Creek System																	
Link90	80.0	Circular	2.0	3.0	263397_NY-0290	Node597	179.70	177.30	187.40	186.35	181.24	179.00	182.73	180.36	33.3	36.3	CIP #2.1
Link91	180.0	Circular	2.0	2.4	Node597	Node598	177.30	173.02	186.35	182.52	179.00	174.72	180.36	175.02	33.3	36.3	CIP #2.1
Link95	190.0	Circular	2.0	2.6	Node598	Node599	172.82	167.92	182.52	173.78	174.44	169.54	174.70	169.76	33.3	36.2	CIP #2.1
Link92	230.0	Circular	2.0	3.4	Node599	Node600	167.72	159.79	173.78	166.36	169.14	161.21	169.24	161.31	33.3	36.2	CIP #2.1
Link93	161.0	Circular	2.0	5.6	Node600	Node602	159.63	150.56	166.36	157.22	160.83	151.76	160.90	151.83	33.3	36.2	CIP #2.1
Link94	162.0	Circular	2.0	7.2	Node602	Node603	150.51	138.77	157.22	146.89	151.61	139.87	151.67	139.93	33.3	36.2	CIP #2.1
Link78	220.0	Circular	2.0	6.6	Node603	NY-0230	138.51	123.97	146.89	130.70	139.65	125.32	139.71	125.58	33.3	36.2	CIP #2.1
Link96	120.0	Circular	2.0	8.6	NY-0230	270963	123.86	113.50	130.70	123.15	125.32	116.00	125.58	116.10	53.5	59.7	CIP #2.1
Link89	400.0	Circular	4.0	1.3	270971	NY-0250	125.30	120.00	130.80	126.15	127.24	125.46	127.55	126.06	52.9	63.3	CIP #2.2
264286	237.6	Circular	4.0	0.4	NY-0250	262213	119.80	118.80	126.15	125.08	125.46	124.81	126.06	125.08	51.2	59.3	CIP #2.2
Link97	150.0	Circular	4.0	0.5	262213	Node569	118.80	118.00	125.08	125.27	124.81	124.61	125.08	124.92	54.6	63.4	CIP #2.2
268297	41.3	Circular	3.0	5.8	262848	262856	142.50	140.10	148.93	147.25	144.70	141.60	145.05	141.82	52.4	62.5	CIP #2.3
268295	119.7	Circular	3.0	5.8	262856	262847_NY-0370	140.00	133.00	147.25	138.76	141.60	134.70	141.82	135.04	52.4	62.5	CIP #2.3
268296	67.6	Circular	3.0	5.9	262847_NY-0370	262846	132.80	128.80	138.76	135.44	134.70	131.06	135.04	131.46	53.1	63.3	CIP #2.3
268293	21.4	Circular	3.5	5.6	262846	262844	128.60	127.40	135.44	132.63	131.06	129.50	131.46	129.82	53.1	63.3	CIP #2.3
267215	50.0	Circular	3.5	4.2	262844	270971	127.40	125.30	132.63	130.80	129.51	127.24	129.83	127.55	53.1	63.3	CIP #2.3
322832	62.1	Circular	2.0	2.4	312443	322831	125.60	124.11	129.32	129.11	126.25	126.29	126.86	126.86	2.1	2.4	CIP #2.3
Link36	484.0	Circular	3.5	2.7	335464	277227_NY-0380	136.18	122.95	141.50	128.95	138.39	127.68	138.91	129.03	89.8	107.5	CIP #7
Blake Street System																	
Link31	120.0	Circular	7.0	1.2	Node1557	Node1566	196.2	194.8	203.5	203.5	201.11	201.88	198.09	199.76	155.5	194.1	CIP #6

Figure E-1. CIP #1 Manhasset Storm System Improvements – Proposed System Node Numbering

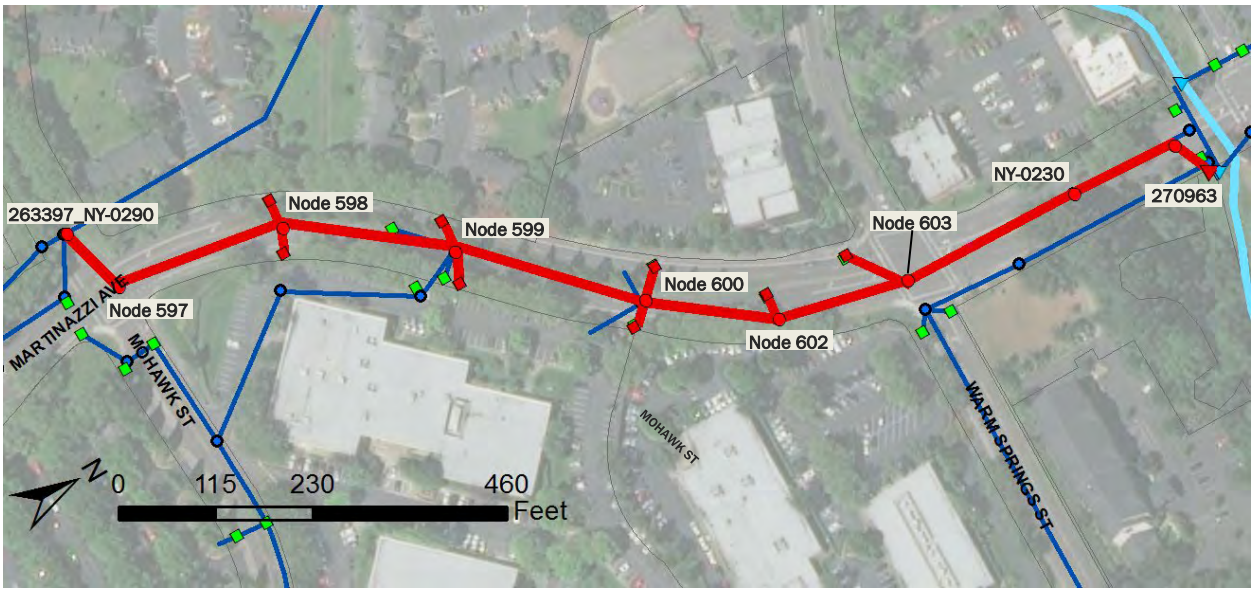


Figure E-2A. CIP #2 Nyberg Creek Stormwater Improvements (Phase 1)– Proposed System Node Numbering

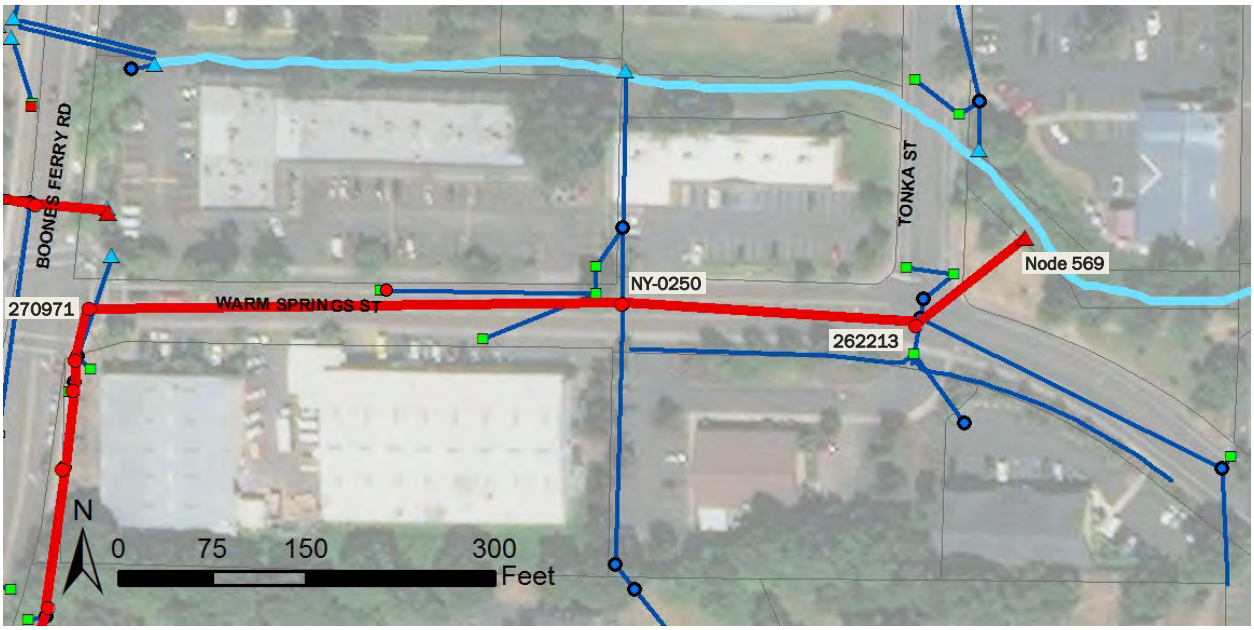


Figure E-2B. CIP #2 Nyberg Creek Stormwater Improvements (Phase 2) – Proposed System Node Numbering

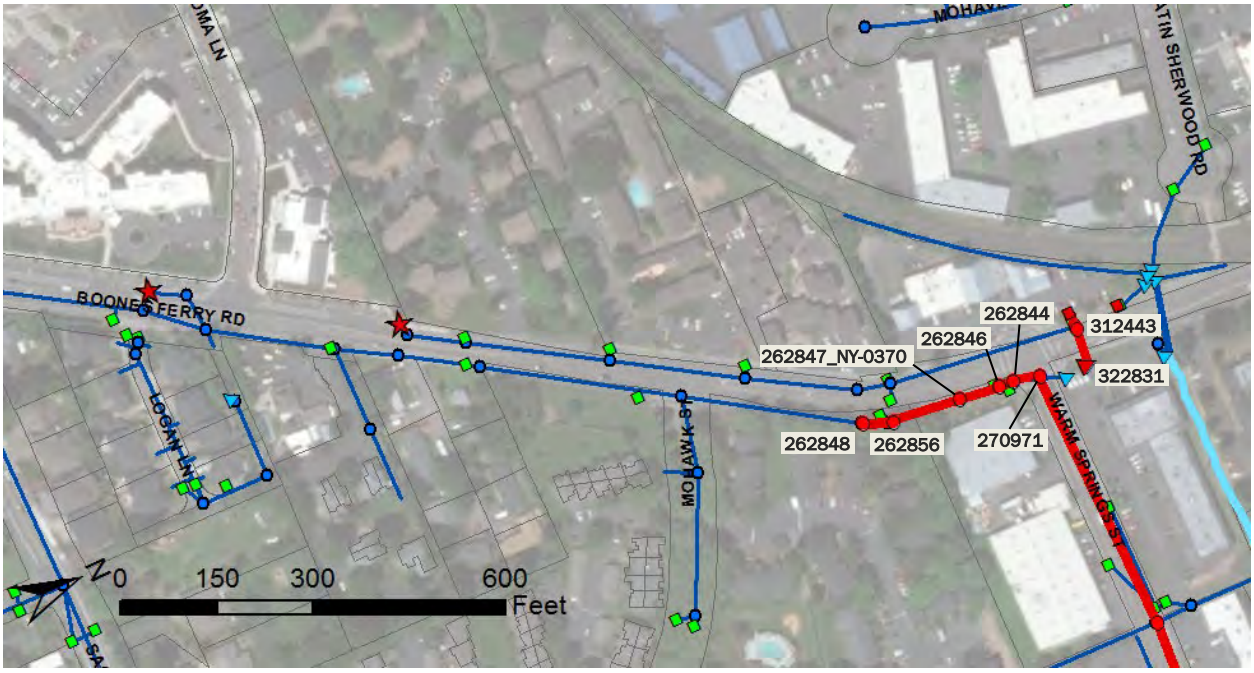


Figure E-2C. CIP #2 Nyberg Creek Stormwater Improvements (Phase 3) – Proposed System Node Numbering

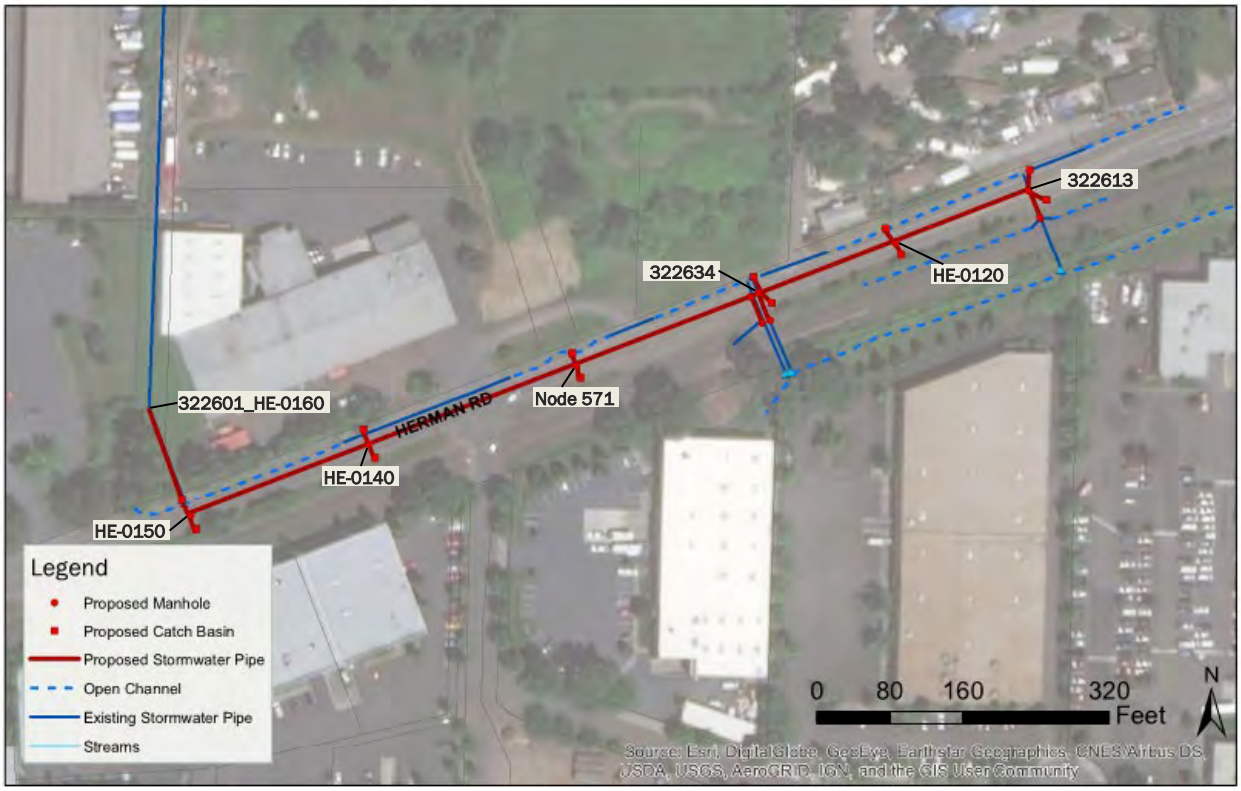


Figure E-3. CIP #5 Herman Road Storm System – Proposed System Node Numbering

Figure E-4. CIP #6 Blake Street Culvert Replacement – Proposed System Node Numbering

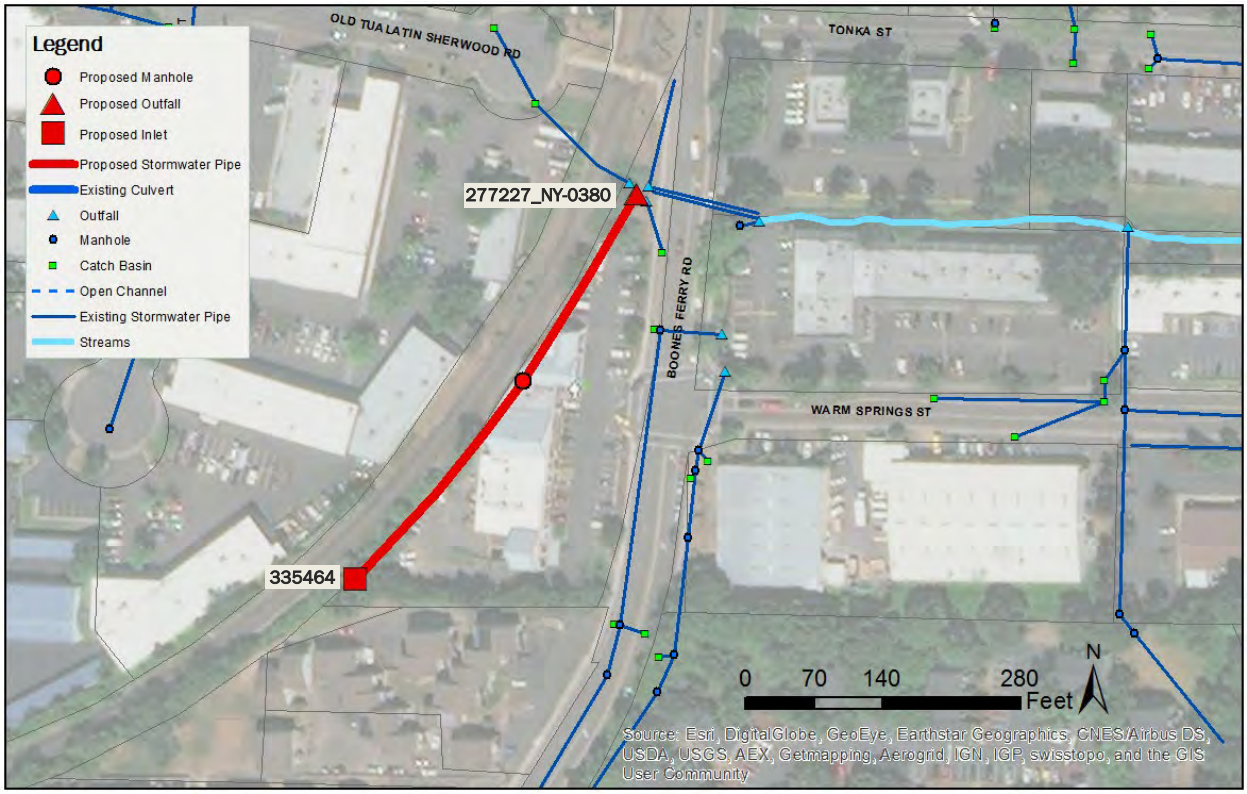


Figure E-5. CIP #7 Boones Ferry Railroad Conveyance Improvements – Proposed System Node Numbering

Appendix F: Stream Assessment TM (TM4)

Stream Assessment

Technical Memorandum

City of Tualatin

Prepared for:
Brown and Caldwell
6500 SW Macadam Avenue #200
Portland, Oregon

January 30, 2018

Finalized: February 17, 2019

Table of Contents

List of Tables

List of Figures

List of Photos

Attachments

Glossary

Aggradation	The process of building up a surface by deposition (as in sediment in a stream channel).
Bankfull Depth	The depth of the channel when discharges are at full channel capacity. Discharges above the bankfull depth would overflow onto the floodplain. Evidence of bankfull depth includes breaks in slope on channel banks, vegetation changes,
Bankfull Width	The width of the channel when discharges are at full channel capacity, measured at the elevation of bankfull depth.
Channel	The deepest part of a stream or water body.
Channel Capacity	The maximum flow a given channel can transmit without overtopping its banks.
Downcutting	Streambed erosion that results in deep, narrow, channels.
Downstream	In the direction that flow is headed, generally to a lower elevation in the case of stream channels.
Erosion	The wearing away of soil and rock by the action of streams, mass wasting, and weathering.
Gradient	The steepness of the channel slope, referred to in percent or feet of drop in elevation per foot length of channel.
Hillslope	The flanks that form the valley walls adjacent to stream channels. Hillslopes are the zones where soil and rock are loosened by weathering processes and transported downgradient.
Incision	Downward erosion, as in a streambed. Synonymous with downcutting.
Reach	A length of stream channel with similar physical characteristics, or length of stream channel between two arbitrarily chosen landmarks, such as road crossings or other logical breaks in open channel flow.
Tributary	Any stream that contributes water to another stream.
Upstream	In the direction that flow originates, generally from a higher elevation in the case of stream channels.

1.0 Introduction and Summary

The Tualatin River is the major surface water feature in the City of Tualatin (City), located north of the City Center. The City manages the surface and stormwater that flows into the Tualatin River through pipes and tributary creeks, as well as flood flows from the river that backwater into tributary channels and stormwater pipes.

The City contracted with Brown and Caldwell for development of their Stormwater Master Plan to evaluate hydrology and stormwater flows, identify system deficiencies, and develop and prioritize capital improvement projects to facilitate long-term economic, social and environmental benefit of residents and businesses in Tualatin. As part of the Stormwater Master Plan, the City wanted to incorporate a stream channel assessment into the overall stormwater system evaluation. Tributary streams to the Tualatin River are an important component of the surface water network in the City. They provide conveyance and storage (both in channel and on floodplains) of water and sediment, and habitat to aquatic and terrestrial species.

This stream assessment technical memorandum (TM) provides supporting documentation for Tualatin's Stormwater Master Plan. A field assessment was conducted on priority reaches along tributary streams in September 2017. Figure 1 shows the locations of the tributary stream reaches assessed. The overall goals of the stream assessment were to:

- Provide a baseline assessment of existing physical stream conditions;
- Identify existing problem areas such as locations of channel instability or excessive erosion that may impact private or public infrastructure;
- Assess the potential for changes and impacts to the stream channel; and
- Recommend capital, operational, maintenance or other solutions for issues identified.

Results of the field assessment include recommendations for strategies that address erosion, invasive vegetation, and hillslope instability. Specific recommendations include:

- Development of policies to encourage onsite retention of stormwater and flow mitigation in neighborhoods where stream channels are susceptible to flashy runoff conditions.
- Development of vegetation management plans for stream reaches that are teeming with invasive vegetation.
- Regular inspection of infrastructure that is being impacted by erosion to monitor for further deterioration in advance of future planned capital projects.

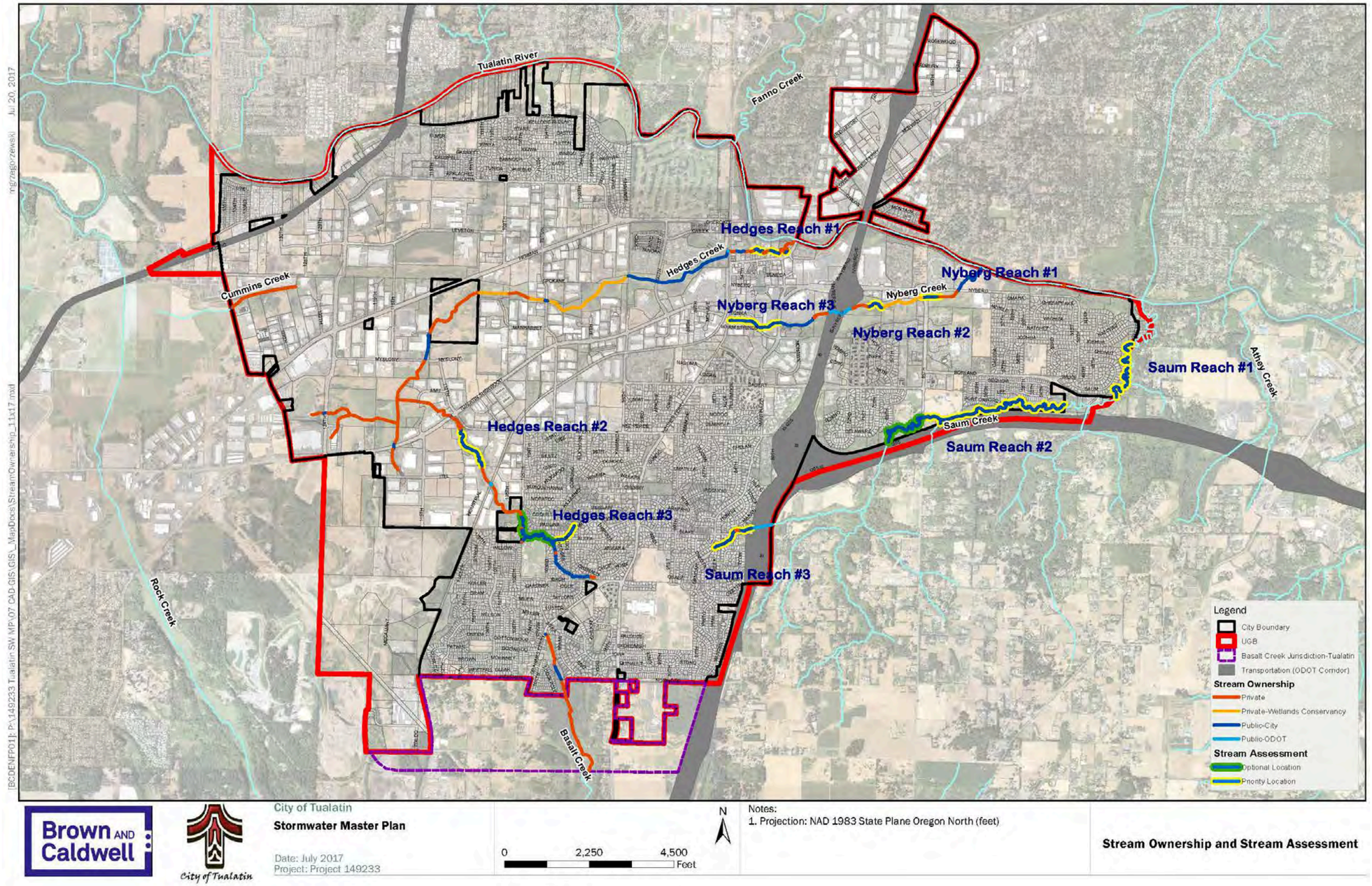


Figure 1. Vicinity Map and Location of Priority Stream Reaches Walked during Stream Assessment

2.0 Methodology

The stream assessment was primarily focused on direct observations gained from conducting stream walks on priority stream reaches along Saum, Nyberg, and Hedges Creeks. Priority stream reaches were identified by City staff based on ownership and a history of staff or citizen complaints/ concerns, and potential for additional stream flows due to new or redevelopment.

Prior to stream walks, maps were generated from geographic information system (GIS) coverages provided by the City. Available GIS data including major roads, City parcels, streams, and wetlands were reviewed and incorporated into field maps. Additionally, regional geologic map information was obtained online (Hart and Newcomb 1965).

The stream walks were conducted by Erin Nelson, Altaterra Consulting and Ryan Retzlaff, Brown and Caldwell between September 11, 2017 and September 15, 2017. Streams were walked in the upstream direction from the lowest point in the reach to the highest point in the reach. Photographs were taken to document conditions (generally in the upstream direction). Physical and biological conditions were noted in a field notebook and mapped with geographic references (such as road crossings) and approximate distances upstream from the starting point. The following stream characteristics were documented:

- General vegetation condition, including presence of native and non-native vegetation
- In-stream and hillslope erosion processes (incision, aggradation and hillslope failures)
- Approximate bankfull stream channel widths and depths, measured at appropriate intervals when conditions change
- General aquatic habitat conditions (pools, riffles, large woody debris, flow)
- Location of stormwater outfalls, pipes and groundwater seeps
- Potential pollution sources
- General in-stream sediment distribution throughout stream channel
- Wildlife activity (presence of beaver dams)

These characteristics were noted because they provide evidence of current aquatic health and physical channel conditions, as well as documentation that can be used to compare future stream assessment results.

Observations made during the stream walks were used to qualitatively identify current stream channel deficiencies and potential strategies for improvement. Hydrologic and hydraulic data, including historic, current or predicted stream discharges was not reviewed relative to the physical channel conditions. Analysis of this data compared to physical channel dimensions could potentially be used to predict future changes.

Table 1 provides a list of the reaches included in the assessment and the approximate reach lengths that were walked. Stream reaches were evaluated from downstream starting point to upstream end point.

Table 1. List of Stream Reaches Walked

Stream	Reach	Starting Point	End Point	Approximate Distance (ft)
Saum Creek	#1	Tualatin River	SW Prosperity Park Road	6,775
	#2	SW Lee Street (east end)	SW 65th Ave	4,950
	#3	SW Blake Street	Upstream 530', downstream vicinity 90'	600
Nyberg Creek	#1	SW Nyberg Lane	SW 65th Avenue	950
	#2	SW 65th Ave	I-5	2,100
	#3	SW Martinazzi Ave	Boones Ferry Road	1,400
Hedges Creek	#1	SW Boones Ferry Road/Tualatin River	SW Tualatin Rd	2,250
	#2	Tualatin-Sherwood Rd	SW Industrial Way	1,900
	#3A	Blake St/SW 105th Ave	Confluence with S. Tributary	1,740
	#3B	Confluence with S. Tributary	SW 99th Ave	560

3.0 Stream Assessment Results

Stream channel characteristics observed during the stream walk and field investigations are described below for each reach. Additional detail is provided in the reach summary sheets included in Attachment A. Physical reach characteristics are summarized in Table 2. This information can be compared to discharge data, if available, to compare physical channel dimensions (channel capacities) to flow.

Table 2. Summary of physical stream channel characteristics by reach.

Stream	Reach	Avg. Gradient (%)	Avg. Valley Width (ft)	Avg. Bankfull Width (feet)	Avg. Bankfull Depth (feet)	Width:Depth Ratio
Saum Creek	#1	0.59	100-200	13.2	5.9	2.2
	#2	0.36	150-175	10.5	4.7	2.2
	#3 (us of Blake)	1.12	75-100	6	2	3.0
	#3 (ds of Blake)	3.0	75-100	nm	nm	nm
Nyberg Creek	#1	<0.001	300-400	nm	nm	nm
	#2	0.09	500-650	nm	nm	nm
	#3	0.3	30-60	6.5	2.5	2.6
Hedges Creek	#1	0.8	75 - 125	11.5	4.2	2.7
	#2	0.2	125-250	11.5	4.3	2.7
	#3A	0.009	~150	10.6	3.7	2.9
	#3B	3.7	~50	5.7	2.8	2.0

Notes: us = upstream, ds = downstream, nm = not measured

3.1 Overall Summary

Some of the notable positive characteristics observed in the stream reaches investigated include:

- wide riparian corridors surround many of the stream channels, which is noteworthy given the otherwise urban/suburban setting of the City
- a distinct lack of trash in and around the channels

Preservation of riparian corridors and floodplains is especially important in low-gradient stream systems, where streams typically have a meandering characteristic and require space to maintain this stable channel form. Moderate and steep gradient streams are usually more confined by narrow valleys and narrower floodplains, and stable channel forms do not necessarily need as much lateral space for movement. However, wide swaths of riparian vegetation in these areas is also very beneficial to channel stability. Healthy riparian corridors in moderate and steep gradient systems supply large wood to channels as trees fall in (providing channel structure), and slope stability benefits through water interception, water uptake, and soil reinforcement from roots.

Negative characteristics observed in many of the stream reaches investigated include the presence of invasive non-native vegetation such as reed canary grass, Himalayan blackberry, jewel weed, and English Ivy. Invasive vegetation was observed in almost every stream reach, although some reaches were heavily impacted.

Physical stream channel conditions generally correlate to the reaches position in the watershed and factors such as riparian width, stream channel gradient, and channel confinement (from development or topographic conditions). Bank and bed erosion was most prevalent in the headwater reaches of the stream channels assessed (e.g., Saum Creek Reach #3 and Hedges Creek Reach #3B), where stream channel gradients were steeper, and channels were confined. These headwater reaches are also exposed to the first effects of high flows during rain events, conveyed from surrounding residential neighborhoods. There is very little in-channel or floodplain storage capacity to dissipate flows. The lower or downstream reaches of the streams generally have wide riparian corridors and floodplains to effectively dissipate peak flows from the channel to the floodplain, reducing the power to erode. Localized bank erosion was mostly observed in the lower reaches on the outside of meanders, where erosion would be expected to occur.

3.1 Saum Creek

Approximately 2 ¼ miles of Saum Creek were assessed between its confluence with the Tualatin River to its headwaters, upstream of I-205, near SW Blake Street. Most of the Saum Creek stream corridor within Tualatin is surrounded by a wide riparian protected greenway (the Saum Creek Greenway downstream of I-5 in Reaches #1 and #2 and the Chieftan/Dakota Greenway upstream of I-5 in Reach #3). Highlights of stream channel characteristics, and problems notes are described below and reach description summary sheets for Saum Creek Reaches #1, #2, and #3 are provided in Attachment A. Photo logs of the stream walks for Saum Creek Reaches #1, #2, and #3 are provided in Attachments B-1 through B-3.

3.1.1 Saum Creek Reaches #1 and #2

The lower reaches (Saum Creek Reach #1 and Reach #2) have the benefit of a wide floodplain to accommodate high flows during flood events. There were no outstanding issues observed in either reach that stood out as needing attention. Minor erosion was observed in both reaches, but there was no indication that the erosion is currently impacting City or private property or infrastructure or that remedies are needed at this time for these minor issues. Non-native invasive vegetation was present along many portions of both reaches, intermixed with native vegetation. The City may wish to develop a vegetation management plan for the Saum Creek Greenway to ensure the success of native vegetation and reduce the proliferation of the non-native invasive species in the corridor.

3.1.2 Saum Creek Reach #3

Saum Creek Reach #3 is divided by SW Blake Street. Downstream of SW Blake Street, a hillslope failure on the north side of the channel has caused the outfall that discharges stormwater piped from SW Makah Ct. to hang several feet above the stream bed (Photo 1). The hillslope failure caused several large trees to fall, resulting in a large number of branches, logs and debris in this reach. The entire north slope was saturated at the time of the site visit. Soil saturation could be a contributing factor to the slope instability in this location. The mechanisms of slope failure were not investigated in detail during the site investigation. Further investigation of the geologic condition along this slope is recommended in order to determine cause of failure and need for hillslope reinforcement.

Photo 1. Hanging culvert on north side of Saum Creek Reach #3 in location of hillslope failure (September 2017)

The channel upstream of SW Blake Street was restored in 2014 with a series of rock check dams and pools. This project was constructed in conjunction with a neighborhood water quality project. Prior to the restoration, the channel in this reach was significantly incised and banks were being eroded from high rates and volumes of stormwater runoff emanating from the surrounding residential development (Otak, 2013). A new stream channel gradient was established through the reach using rock weirs and splash pools to dissipate the energy (Photo 2) and the entire corridor was revegetated with native vegetation. A current view of the restoration area is shown in Photo 3. The channel structure (boulders and drop pools) is intact and erosion does not appear to be a current problem in this reach. However, the lower portion of the reach immediately upstream of SW Blake Street is very flat, and the ground is saturated (Photo 4). Saturated conditions, as well as the presence of invasive vegetation appear to be impacting native plants that have been planted in this corridor. There is a need for ongoing vegetation maintenance in the entire reach, but particularly in this area where an investment has already been made on the stream restoration project. Plant selection and/or locations may need some adjustment for the best chance of success.

Photo 2. Otak photo of newly constructed Saum Creek channel in Chieftan/Dakota Greenway (c. 2013)

Photo 3. Saum Creek restoration in Chieftan/Dakota Greenway (September 2017)

Photo 4. Saum Creek immediately upstream of SW Blake Street. Channel is obscured by reed canary grass. This area is very flat, and wet.

3.2 Nyberg Creek

Three reaches (approximately 0.84 miles) of Nyberg Creek between SW Nyberg Lane and SW Boones Ferry Road were assessed and/or walked as part of the stream assessment. Highlights of stream channel characteristics and problems noted are described below and reach description summary sheets for Nyberg Creek Reaches #1, #2, and #3 are provided in Attachment A. Photo logs of the stream walks for Nyberg Creek Reaches #1, #2, and #3 are provided in Attachments B-4 through B-6.

3.2.1 Nyberg Creek Reaches #1 and #2

Nyberg Reach #1 and Nyberg Reach #2 were mostly lacking stream channel characteristics at the time of the stream assessment. These reaches are wetland complexes with significant open water components (Photos 5 and 6). Beaver activity is prevalent, and is likely the reason for the extensive open water in these two reaches. There was evidence of past efforts to address the beaver activity in Nyberg Creek Reaches #1 and #2. However, the beaver activity observed did not appear to be in areas of concern with regard to infrastructure or flooding. Vegetation in Nyberg Creek Reaches #1 and #2 consisted of wetland vegetation. Due to the on-going beaver activity and the changing nature of the flooded areas that currently have wetland characteristics, there is no recommendation for vegetation management.

Photo 5. Nyberg Creek Reach #1 downstream of SW 65th Avenue

Photo 6. Nyberg Creek Reach #2 downstream of I-5, with beaver swimming in foreground.

3.2.2 Nyberg Creek Reach #3

Nyberg Creek Reach #3, between SW Martinazzi Avenue and Boones Ferry Rd has much different physical characteristics than Nyberg Creek Reach #1 and Reach #2. This reach is primarily confined to a narrow swath of open space between commercial development. Immediately upstream of SW Martinazzi Avenue, a notched concrete dam is present, creating a pond (known by City staff as Izzy's Pond) on the upstream side. Upstream of the pond, the channel is piped for approximately 100 feet in a strip mall parking lot. The remainder of the reach consists of open channel that is straight, narrow, and dominated by reed canary grass (Photo 7). Vegetation management is needed in this entire reach, including removal of invasive reed canary grass and replacement with other appropriate native vegetation.

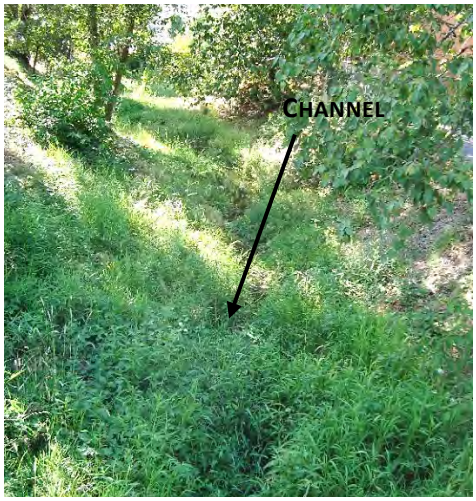


Photo 7. Nyberg Creek Reach #3 upstream of SW Martinazzi Avenue.

3.3 Hedges Creek

Approximately 1 ¼ miles of Hedges Creek was assessed between the Tualatin River and the headwaters near SW 99th Ave. in the Ibach Park neighborhood. Hedges Creek is almost entirely within the City of Tualatin jurisdictional boundary, but much of it is under private ownership. Only a small portion of the stream was walked, at the mouth and at the headwaters. Three independent reaches (Reach #1, #2, and #3) were selected for investigation because of known issues and/or City property ownership. Reach #3 was further divided into two sub-reaches, Reach #3A and Reach #3B, because there were distinctly different characteristics observed in the downstream (#3A) and upstream (#3B) portions of the reach. Highlights of stream channel characteristics and problems notes are described below and reach description summary sheets for Hedges Creek Reaches #1, #2, #3A, and #3B are provided in Attachment A. Photo logs of the stream walks for Hedges Creek Reaches #1, #2, #3A, and #3B are provided in Attachments B-7 through B-10.

3.3.1 Hedges Reach #1

Hedges Reach #1 extends from the Tualatin River to SW Tualatin Road. This reach reflects a mix of public and private ownership and is partially located within Tualatin Community Park property. The lower 1,200 feet of the channel includes meandering characteristics, except for a few straight sections. In general, the straight sections correspond with sections where the channel bed consists of hard silt. The channel bed otherwise consisted of loose sediment (fine silt and sand, with occasional gravel) in Hedges Reach #1.

Bank erosion was observed in Hedges Reach #1 at a few locations on the outside of meander bends in the first 500 feet upstream of the Tualatin River. Rip-rap armoring was observed at one location on private property approximately 450' upstream from the Tualatin River, and a concrete apron was observed on private property at another location 200' upstream from the Tualatin River. It appears that these materials were used to stabilize the stream banks, prevent erosion, and protect private property. The bank stabilization efforts appear to be locally effective in protecting property in the immediate vicinity of the stabilization.

The channel gradient is steeper in the lower (downstream) portion of the reach, flattening out in the upstream portion towards Tualatin Road.

A channel-spanning debris jam was present approximately 300 feet upstream from the mouth of the channel. This debris jam may be associated the event that washed out a private bridge approximately 500 feet upstream from the mouth. The debris and gravel deposited downstream of the bridge wash-out is still present in the channel and the culvert (Photo 8) that conveys water through the debris, directs water toward the opposite bank, due to its orientation. It is not clear whether the culvert was placed in the channel pre- or post- bridge wash out, but the culvert is undersized for the volume of flow received in the channel. The area of the culvert is smaller than the bankfull channel capacity upstream and downstream. High flows would back up at this location and eventually overtop the road and result in erosion. The channel makes a 90 degree turn against a vertical bank, 30 feet downstream of the culvert. Due to the orientation of the stream channel and the culvert which concentrates and directs flow in this location, this bank is at risk of erosion, and may be a potential threat to a private structure located on the top of the bank.

Approximately 200 feet downstream, another private structure is located on the top of the bank on the outside bend of a meander. This structure may have similar risks due to proximity to the edge of the bank. Both of these structures are east of SW Martinazzi Ave and north of SW Boones Ferry Road.

Photo 8. Culvert placed in debris from washed out bridge to convey Hedges Creek.

Approximately 1,200 feet upstream of the mouth, an 18-inch diameter stormwater outfall enters Hedges Creek from the south. Stormwater inputs at this location could account for some of the differences in stream characteristics upstream. Upstream of this location, in the Tualatin Community Park, the channel is mostly straight, with a wider floodplain, and a flatter gradient, and based on the channel conditions, erosive flows appear to be less frequent. No channel erosion was observed in this part of the reach. The channel is also largely overgrown with reed canary grass through this portion of the reach (Photo 9), and beaver dams were also observed. Vegetation management is needed to control reed canary grass in the Tualatin Community Park.

Photo 9. Hedges Creek Reach #1. Reed canary grass-choked channel downstream of Tualatin Road.

3.3.2 Hedges Reach #2

Hedges Creek Reach #2 is located between SW Tualatin-Sherwood Road and SW Industrial Way. It is surrounded by the Hedges Creek Greenway open space, a wide riparian floodplain area. Hedges Creek is relatively stable through this reach, with only minor erosion observed on the outside of meanders. The adjacent floodplain provides ample room for the channel to naturally meander and migrate. However, the entire reach needs extensive vegetation management due to observed, dense invasive plants including Himalayan blackberry and reed canary grass, as shown in Photo 10.

Photo 10. Hedges Creek Reach #2.

3.3.3 Hedges Reach #3A

Hedges Creek Reach #3A is located between SW 105th Avenue/Blake Street and a tributary that enters Hedges Creek from the South downstream of SW Alsea Ct. A pedestrian bridge crosses the stream channel in this location.

Hedges Reach #3A has a meandering characteristic and a relatively low gradient. Channel substrate consists of loose silt, hard silt, and an outcrop of bedrock present for about 100 feet of stream channel starting approximately 500 feet upstream of 105th Avenue. A rock wall protecting the bank (and presumably road embankment) 175 feet upstream and on the east side of 105th Avenue/Blake Street has been compromised, as it has been eroded by the stream (Photo 11). At this location, Hedges Creek makes a 90-degree turn, which is a point of maximum velocity and energy on the outside bend. It is recommended to reinforce/ rebuild the rock wall to ensure the road embankment is not compromised and/or reorient the culvert under 105th Avenue/ Blake Street to minimize flow velocity directed at the road embankment and wall. It is assumed that design and construction would be conducted in conjunction with the scheduled road widening project for 105th Avenue.

Another issue observed in Reach #3A is channel incision in a side channel entering the main channel from the south, approximately 700 feet upstream of SW 105th Avenue. The neighborhood west of Ibach Park contributes drainage to this side channel and it appears that this channel receives a large volume of water from the upstream catchment. The extreme erosion in this side channel has exposed a sanitary sewer manhole (Photo 12). This exposure, over time, may compromise the structural integrity of the manhole.

Evidence of a recent stream restoration project was observed upstream of Ibach Park (Photo 13), starting approximately 950 feet upstream of SW 105th Avenue. Large wood, bed protection matting and tiles, and root wads were placed and cabled at several different locations in the channel. It is unclear based on the locations of the restoration efforts what the goals might have been. Bank erosion and hillslope slumps were observed throughout the reach, however, property or infrastructure did not appear to be impacted or immediately threatened by the erosion. Invasive vegetation, including English ivy, and Himalayan blackberry were present throughout the reach as well.

It is recommended that locations of active channel erosion, in the vicinity of the rock wall and the sanitary sewer pipe, in this reach be monitored by the City to ensure that site conditions do not deteriorate. Additionally, the side channel entering Hedges Creek in Reach #3A has experienced erosion due to the flashiness of stormwater runoff from upstream. Flow control and onsite retention standards and policies are recommended for the City's consideration in Hedges Reach #3A, in the vicinity of the area west of Ibach Park, to mitigate for areas of active erosion and preserve the integrity of small streams such as this side channel.

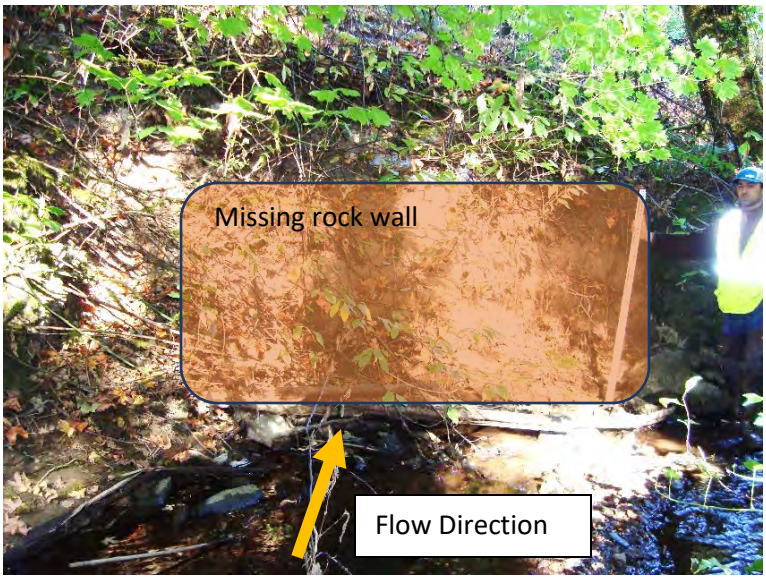


Photo 11. Hedges Creek Reach #3A, showing rock wall location and missing rocks.

Photo 12. Side channel incision and erosion around sanitary sewer manhole.

Photo 13. Restoration area showing cabled logs and root wads. Approximately 950 feet upstream of SW 105th Avenue.

3.3.4 Hedges Reach #3B

Hedges Creek Reach #3B is located between a tributary that enters Hedges Creek from the South downstream of SW Alsea Ct and SW 99th Avenue.

Hedges Reach #3B has a much steeper gradient that Reach #3A and the channel is incised with the width to depth ratio decreasing upstream along the reach. The channel is not stable in this reach. Adjacent slopes have failed on both banks (Photo 14) and the culvert under SW Alsea Ct. is perched resulting from erosion and downcutting at the base (Photo 15).

Photo 14. Left bank slump upstream of confluence.

Photo 15. Perched culvert on downstream side of SW Alsea Ct.

Further upstream of SW Alsea Ct. to SW 99th Ave, there is more evidence of erosion and downcutting. A culvert delivering water to the head of the channel near 9999 SW Alsea Ct. is perched approximately 6 feet above the current channel. The culvert is actively eroding the channel. It appears the channel receives a large volume of water from the upstream catchment. BC estimates approximately 140 acres of residential development is collected and conveyed undetained to this stream reach. Given the susceptibility to headwater channels to experience erosion due to the flashiness of stormwater runoff, flow control and onsite retention standards and policies are recommended for the City's consideration in Hedges Reach #3B to mitigate for areas of active erosion and preserve the integrity of the headwater channels.

4.0 Findings and Recommendations

As part of the City's stormwater master plan development, the City is defining projects and strategies to enhance or protect City resources and address stormwater-related problems occurring on City property. This stream assessment was focused on publicly owned land and resources. Findings and recommendations have been identified and developed specific to reaches observed, and do not reflect all stream conditions in the City.

The following is a summary of findings from the stream assessment and recommendations of strategies, including programmatic, projects, and policies to improve stream channel conditions in the reaches evaluated, and/or solve site specific problems.

4.1 Channel Erosion and Incision

Channel erosion and incision was primarily observed in Hedges Creek, and particularly in the headwaters in Reaches #3A and #3B. Table 3 summarizes the locations of channel erosion that were considered problematic from the standpoint of being a risk to property or infrastructure, and recommended strategies for addressing the situation.

Table 3. Summary of Channel Erosion Observations and Recommended Strategies

Stream	Reach	Approximate Location and Issue	Ownership	Recommended Strategy
Hedges Creek	#1	~500 ft. upstream of Tualatin River (washed out bridge)	Private	1. As of the writing of this report, the City is currently working with the property owner and other resource agencies to address permit compliance.
	#3A	~175 ft. upstream of SW 105th Ave. (rock wall)	City	1. Inspect rock wall for ongoing deterioration. 2. Repair rock wall in conjunction with road project. 3. Reorient the downstream culvert to minimize flow velocity directed at embankment.
	#3A	~700 ft. upstream of SW 105th Ave. (side channel and exposed sanitary	City	1. Consider policies to encourage onsite retention and flow mitigation. 2. Inspect sanitary sewer manhole for ongoing exposure or deterioration.

		sewer manhole)		
	#3B	Entire stream reach (erosion and instability)	City/ Private	Consider policies to encourage onsite retention and flow mitigation.
	#3B	Culvert at 9999 SW Alsea Ct. (extreme downcutting)	City	1. Consider policies to encourage onsite retention and flow mitigation. 2. Implement channel reconstruction/stabilization project to protect private property (private property owner).

4.1.1 Flow Control

The physical conditions of Hedges Creek Reach #3 indicate that the stream channel is subjected to high flow volumes on a regular basis. There is significant erosion and downcutting at the base of two culverts and in the channel (adjacent to house 9999 SW Alsea Ct, and downstream of SW Alsea Ct) as well as bank and hillslope failures in this reach. Additionally, a side channel entering Hedges Creek near Ibach Park has experienced extreme incision, likely due to altered hydrology upstream. This side channels exposed a sanitary sewer manhole, and if the channel continues to downcut, it may further threaten the integrity of the sewer structure. Altered hydrology (from forested/ undeveloped conditions to residential development) has impacted this reach. These observed locations (see Table 3) may benefit from implementation of flow control design standards aimed at reducing both the peak flow and the duration of channel forming flows entering this reach. The City does not currently require stormwater detention or flow mitigation in conjunction with new and redevelopment and coordinates with Clean Water Services on stormwater management and stormwater design standards. The City may consider updates to their stormwater management policy to encourage onsite retention and flow mitigation in areas susceptible to hydromodification impacts, such as Hedges Reach #3.

It should be noted that flow control may not be as effective in the downstream reaches (i.e., Hedges Reach #1) because of wide floodplains and wetlands are effective at dissipating flow and reducing erosivity. It is recommended that hydrologic and hydraulic modeling be conducted to model the potential effects of flow control standards on downstream reaches.

4.1.2 Road Embankment Erosion

The rock wall protecting the road embankment on 105th Avenue/Blake Street from Hedges Creek in Reach #3A was observed to be failing. Rocks have fallen into the stream, and only a few pieces of the wall remain in place. It is understood that the City plans to widen SW 105th Avenue, which will require a detailed evaluation and updated design of the road embankment and culvert crossings in relationship to the stream channel. A potential design option is to reorient the culvert in conjunction with the roadway widening project to mimic the direction of the natural stream channel and minimize flow velocity directed at the road embankment. Alternatively, reinforcement/ replacement of the existing rock wall would be needed.

4.2 Vegetation Management

Nearly all the reaches assessed were impacted by invasive vegetation, with the most common species being reed canary grass, Himalayan blackberry and English Ivy. Specific locations where intense vegetation management is recommended is detailed in Table 4.

Table 4. List of Locations Recommended for Vegetation Management

Stream	Reach	Location	Ownership	Invasive Vegetation	Approximate Distance (ft)
Saum Creek	#3	Upstream of SW Blake Street in vicinity of existing restoration project (maintenance is needed).	City	Reed canary grass, Himalayan Blackberry	Approximately 200
Nyberg Creek	#3	Entire reach	Mostly City, approximately 300 feet private	Reed canary grass	1,400
Hedges Creek	#1	Tualatin Community Park	City	Reed canary grass	~500
	#2	Entire reach	City	Reed canary grass, Himalayan Blackberry	1,900

Hedges Reach #2 has the most potential for improvement. This area is within the Hedges Creek Greenway and there are established deciduous and conifer trees in the riparian corridor that provide significant shade and would aid in the establishment of newly planted vegetation if a revegetation effort was initiated. Invasive plants are successful because they thrive in environments where native plants struggle, such as areas that lack shade. Providing a hospitable environment for new plant growth, including shade from established trees, will make restoration efforts more successful.

Vegetation management efforts should include a plan for removal of invasive vegetation, replacement with native vegetation of appropriate type and quantities to be successful, irrigation (initially, until plants are established), follow-up monitoring, and on-going maintenance to continue invasive plant removal. Any efforts to remove invasive vegetation and replant with native riparian plants will require a long-term commitment to maintaining the restored areas to ensure success. At a minimum, annual inspections and potential maintenance (depending on the results of inspection) should occur following re-vegetation efforts. If annual inspections indicate no maintenance is needed, the frequency of inspections can be decreased.

4.3 Slope Stability

Results of the stream assessment identified one location where a capital project may be developed to address City infrastructure potentially susceptible to failure. A perched stormwater pipe above the stream channel in Saum Creek Reach #3 was identified during the stream assessment. Stormwater discharge from this pipe will cause further erosion of the slope around it if left in its current position. A capital project is recommended to replace the pipe and repair the hillslope failure in the vicinity in conjunction with the pipe replacement. The new pipe should be placed on the hillside (i.e., thick-walled flexible pipe or similar) to the bottom of the slope, with energy dissipation provided. A geotechnical evaluation is recommended in order to determine the cause of the slope failure in the vicinity of the perched pipe, and provide input to the slope repair design.

5.0 References

D.H. Hart and R.C. Newcomb. USGS. Geology and Ground Water of the Tualatin Valley, Oregon. Water Supply Paper 1697. 1965. Accessed online. https://pubs.er.usgs.gov/publication/wsp1697

Otak 2013. Saum Creek Hydromodification and Water Quality Retrofit. Accessed online. http://www.otak.com/news/media/saumcreekhydromodificationandwaterqualityretrofittualatinoregon/

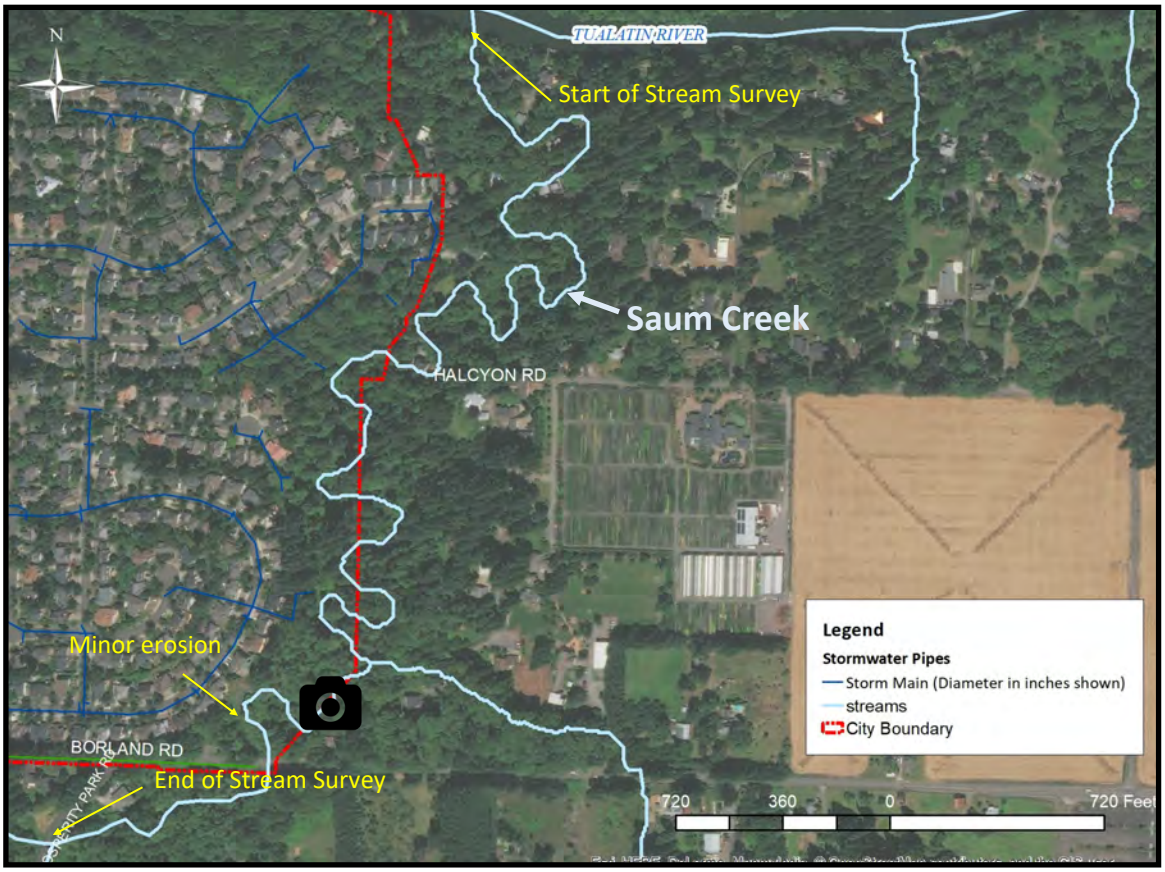
Attachment A

Stream Reach Summary Sheets

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions

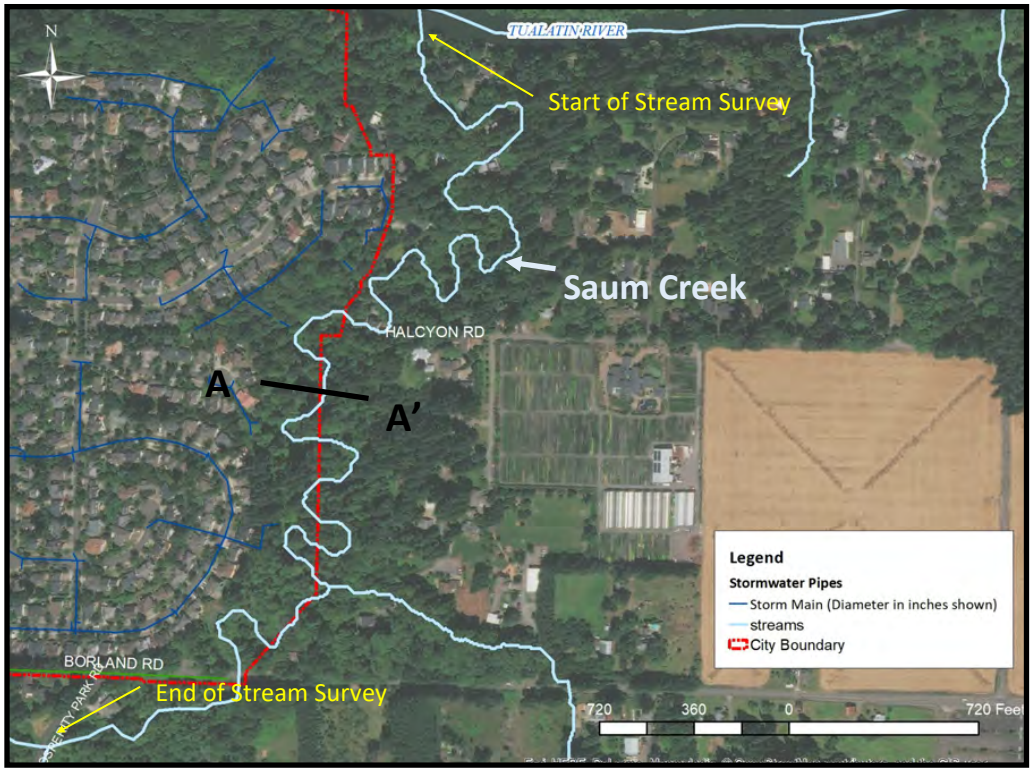
Beaver dam ~ 700 ft. downstream of Borland Rd (photo location shown below with camera icon)

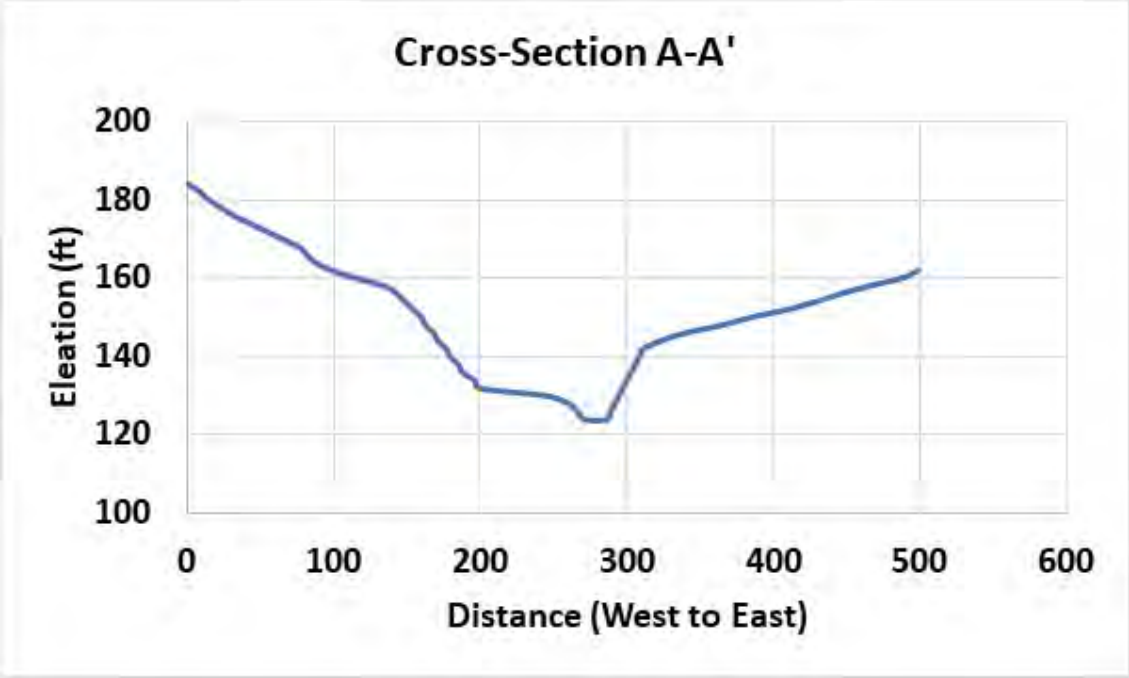
Stream	Saum Creek
Reach	#1 (Tualatin River to SW Prosperity Park Rd)
General Characteristics	
Reach Length:	~6,775 ft.
Gradient:	~0.6%
Valley Width:	~100—200 ft
Planform:	Meandering
Average BFW:	~13’ (range 12’ to 15’)
Average BFD:	~6’ (range 4’ to 7’)
Substrate:	Predominantly silt, some small gravel
Vegetation:	Invasive vegetation (reed canary grass, blackberries, ivy), Douglas fir
Beaver Activity:	Yes. Four beaver dams observed.
Issues:	Minor erosion downstream of Borland Rd.



Aerial view of Saum Creek Reach #1 (Tualatin River to Prosperity Park Road)

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions





Generalized topographic cross section of Saum Creek Valley in Reach #1.

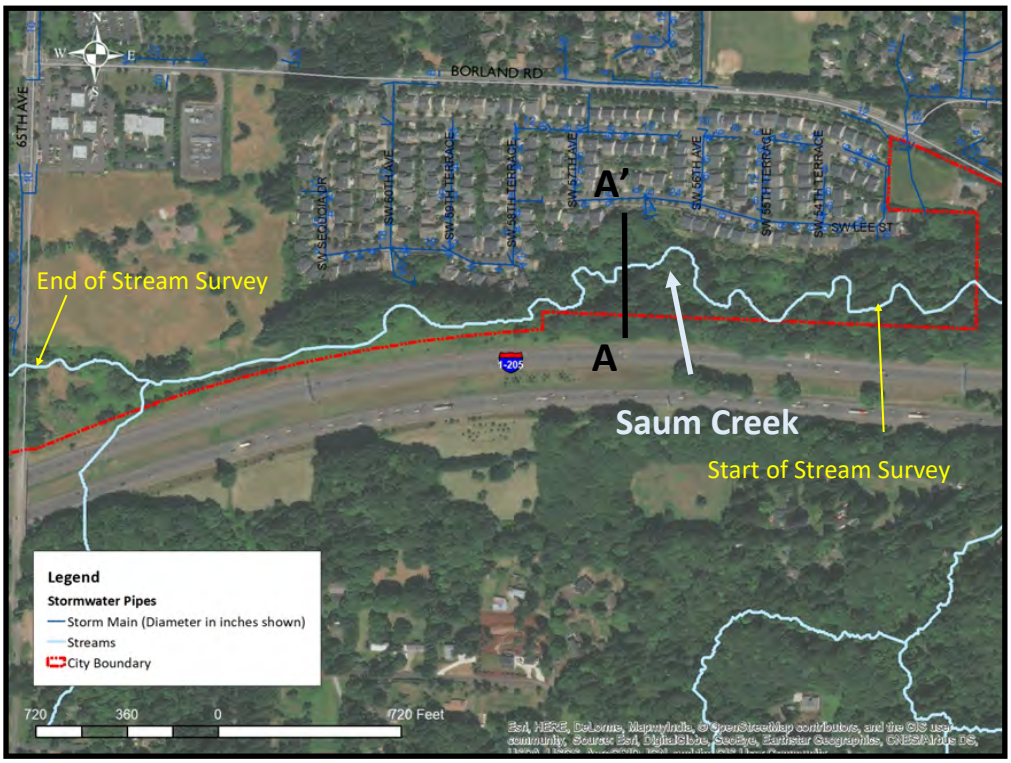
City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions

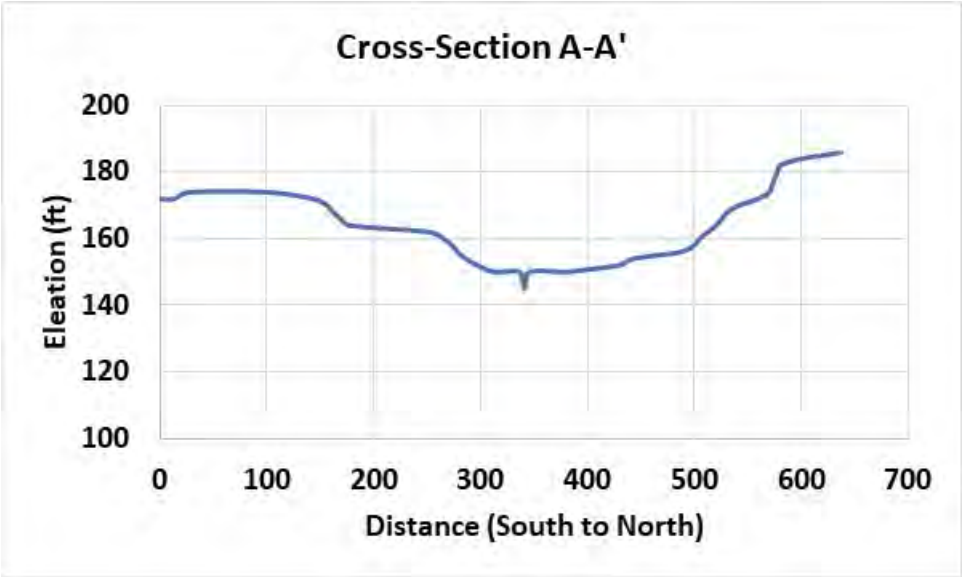
Hard clay forming pools within channel bed in Saum Creek Reach #2 (photo location shown below with camera icon)

Stream	Saum Creek
Reach	#2 (Lee St. to 65 Ave.)
General Characteristics	
Reach Length:	~4,950 ft.
Gradient:	~0.4 %
Floodplain Width:	~150' - 175'
Planform:	Meandering (Lee St. to SW 60th, straight (SW 60th to 65th Ave)
Average BFW:	~10' (range 8' to 15')
Average BFD:	~5' (range 3' to 6')
Substrate:	Silt, hard clay, occasional gravel
Vegetation:	Mixed floodplain forest (maples, alders, firs), reed canary grass, jewel weed, blackberries, ferns, willows, sedges
Beaver Activity:	None observed.
Issues:	No critical issues.

Aerial view of Saum Creek Reach #2 (SW Lee Street to 65th Avenue)

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions



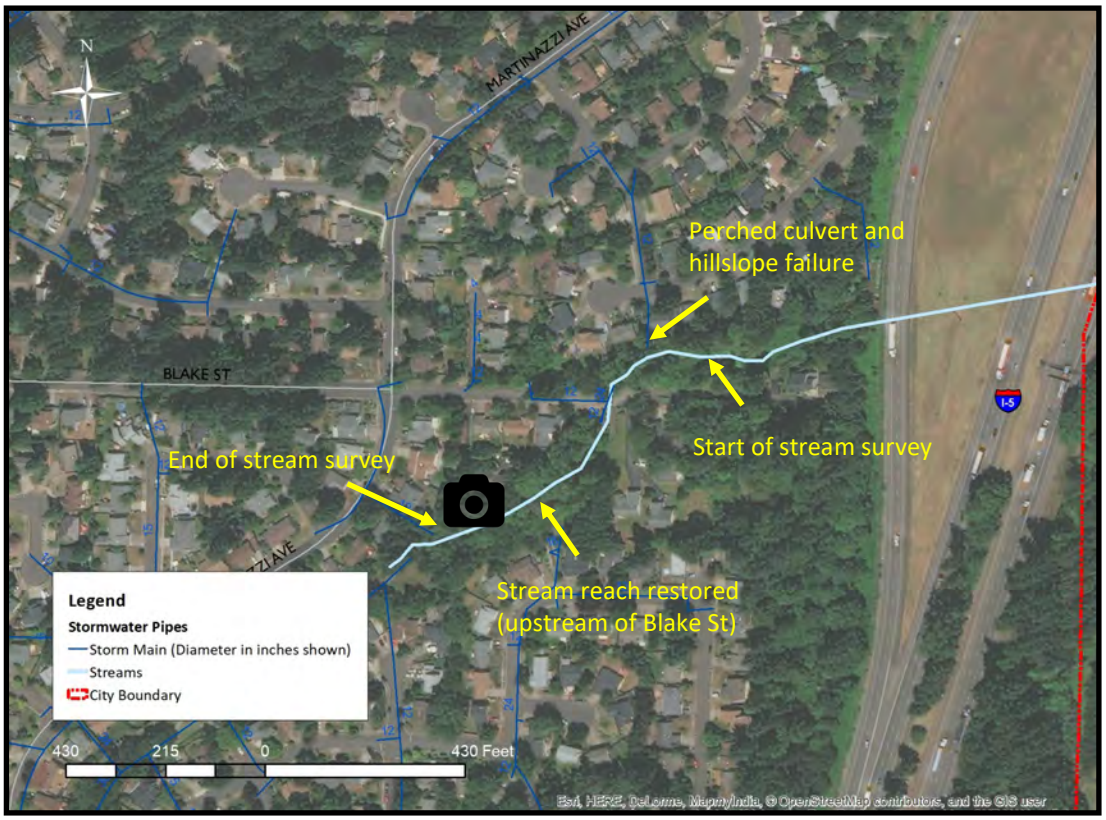


Generalized topographic cross section of Saum Creek floodplain in Reach #2.

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions

Rock check dam and pool in restored section up-stream of Blake Street (photo location shown below with camera icon)

Stream	Saum Creek
Reach	#3 (Vicinity of Blake Street)
General Characteristics	
Reach Length:	~600 ft.
Gradient:	~1.1 % (ds of Blake), ~3% (us of Blake)
Valley Width:	~75’ to 100’ (confined)
Planform:	Straight
Average BFW:	~6’
Average BFD:	~2’
Substrate:	Fine sediment
Vegetation:	Conifer and deciduous trees (many down in channel), reed canary grass, ivy
Beaver Activity:	None observed.
Issues:	Unstable hillslope and perched culvert, invasive vegetation.

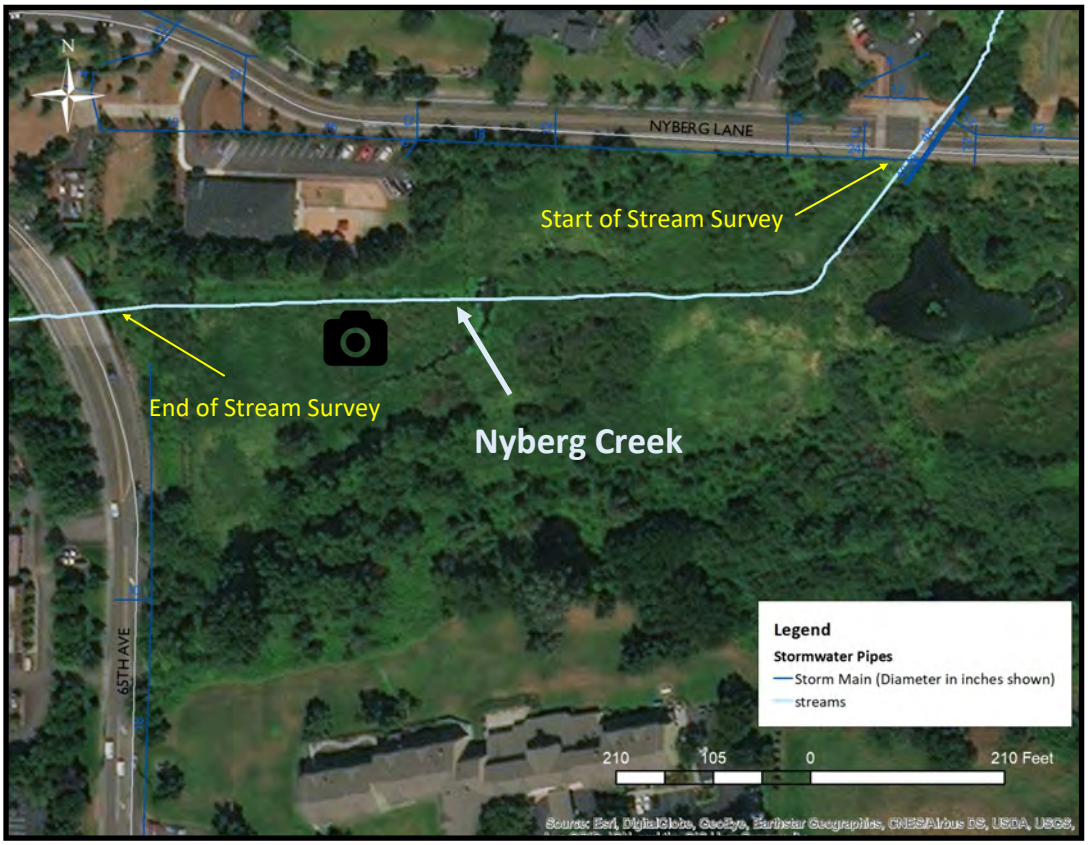


Aerial view of Saum Creek Reach #3 (Vicinity of Blake Street)

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions

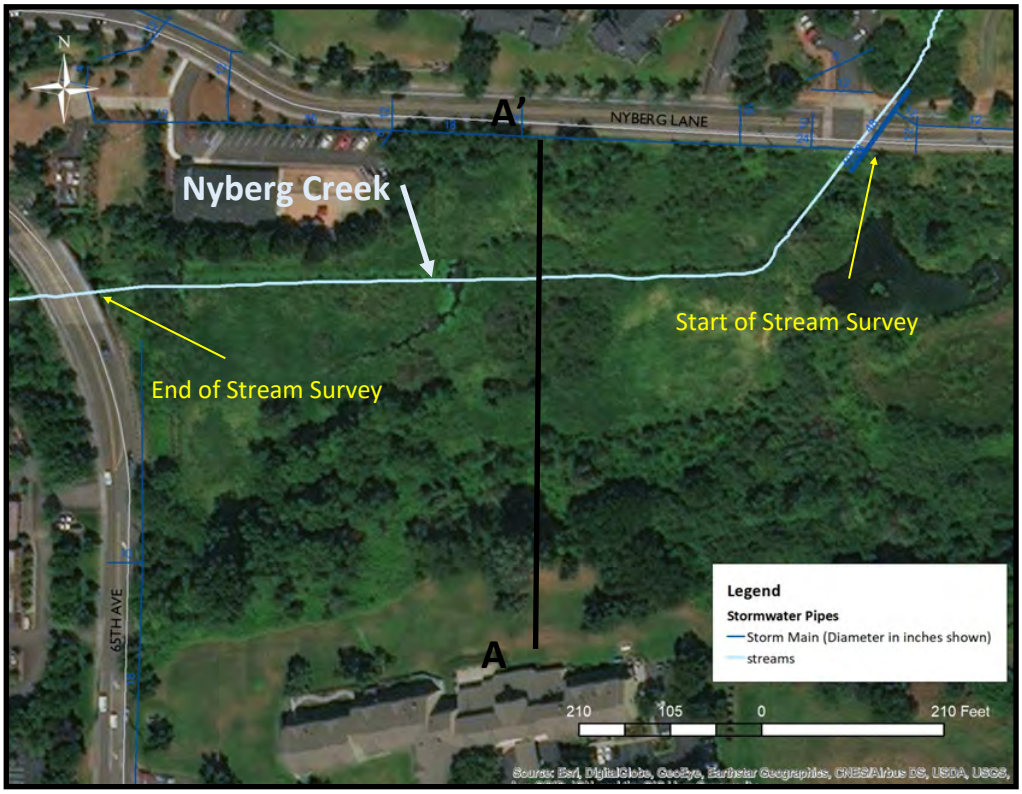
Ponded area in Nyberg Creek Reach #1 down-stream of 65th Avenue (photo location shown below with camera icon)

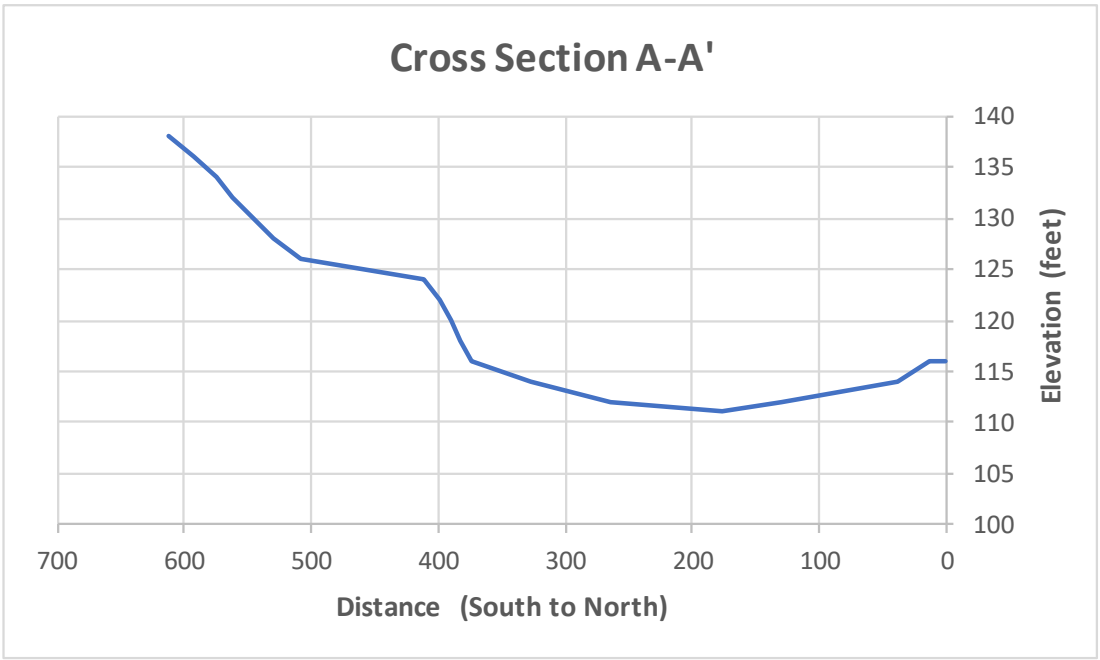
Stream	Nyberg Creek
Reach	#1 (Nyberg Lane to 65 Ave.)
General Characteristics	
Reach Length:	~950 ft.
Gradient:	~0.001% (almost flat)
Floodplain Width:	~300 –400’
Planform:	Straight, ditch-like or undefined channel (wetland, floodplain)
Average BFW:	Not measured. Mostly no single-thread channel. Multiple flow pathways.
Average BFD:	Not measured.
Substrate:	Loose silt and decaying vegetation.
Vegetation:	Wetland plants, reed canary grass, duck-weed, spiraea, jewel weed
Beaver Activity:	Yes, at least two beaver dams in reach.
Issues:	No critical issues.



Aerial view of Nyberg Creek Reach #1 (Nyberg Lane to 65th Avenue)

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions





Generalized topographic valley cross section of Nyberg Creek floodplain.

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions

Nyberg wetlands between 65th Avenue and I-5
(photo location shown below with camera icon)

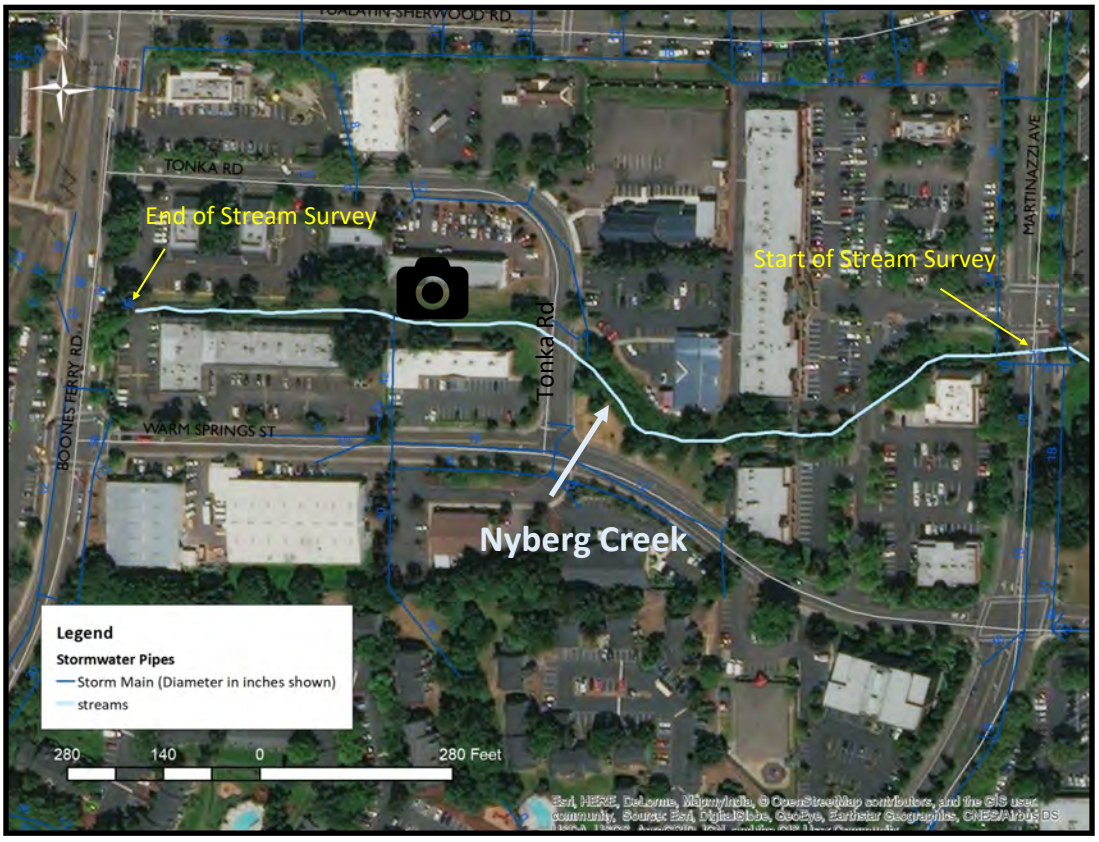
Stream	Nyberg Creek
Reach	#2 (65 Avenue to I-5)
General Characteristics	
Reach Length:	~2,100 ft.
Gradient:	~0.095%
Floodplain Width:	~500-650’
Planform:	Flooded, no channel.
Average BFW:	No channel. Not measured.
Average BFD:	No channel. Not measured.
Substrate:	Not evaluated. Flooded.
Vegetation:	Wetland plants, reed canary grass, duck-weed, spiraea, jewel weed
Beaver Activity:	Extensive. Major beaver dam, and beavers observed during field visit.
Issues:	No critical issues.

Aerial view of Nyberg Creek Reach #2 (65th Avenue to I-5)

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions

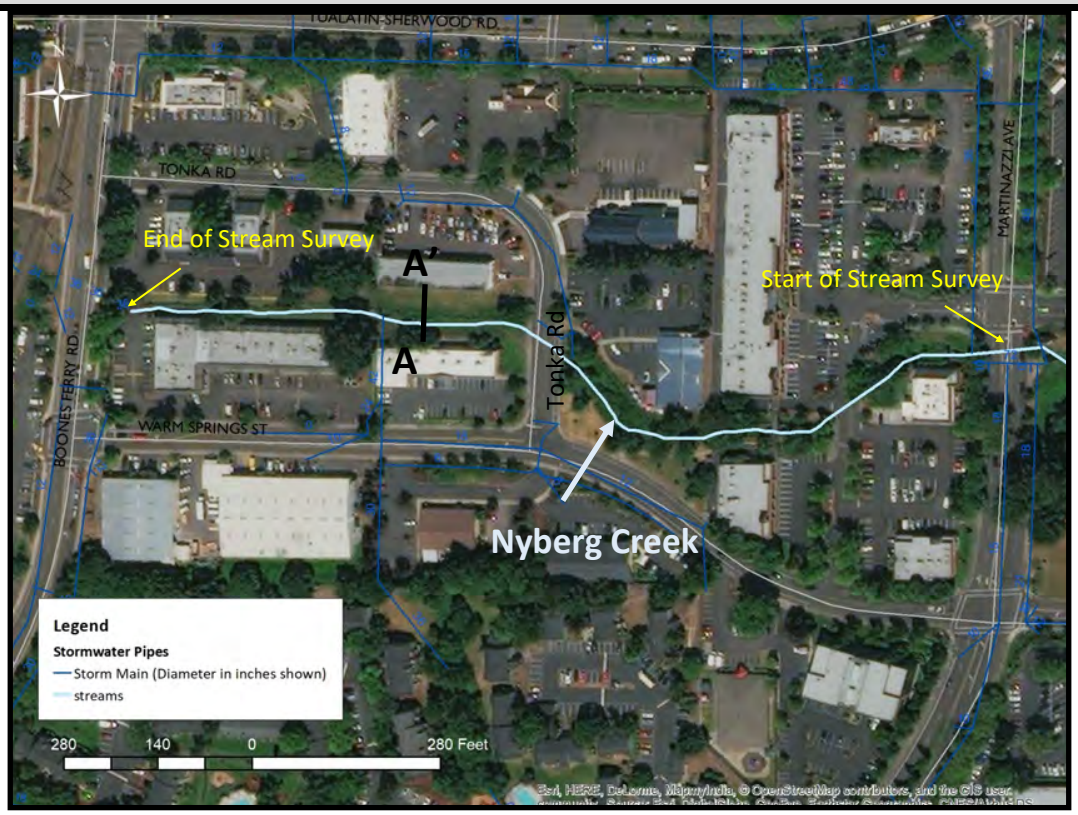
Nyberg Creek between Tonka Rd and Boones Ferry Rd. (photo location shown below with camera icon)

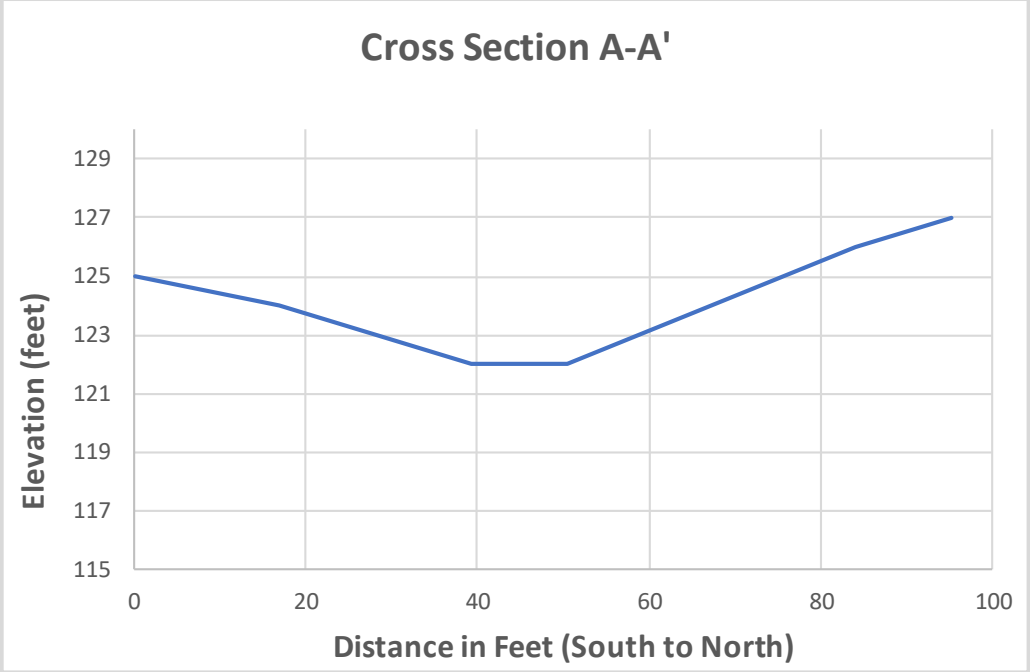
Stream	Nyberg Creek
Reach	#3 (Martinazzi Road to Boones Ferry Rd)
General Characteristics	
Reach Length:	~1,400 ft.
Gradient:	~0.29%
Valley Width:	~30-60’ (channel is confined by development)
Planform:	Straight, confined by development
Average BFW:	~6.5’
Average BFD:	~2.5’
Substrate:	Fine silt.
Vegetation:	Dominated by reed canary grass, few deciduous trees.
Beaver Activity:	No.
Issues:	No critical issues.



Aerial view of Nyberg Creek Reach #3 (Martinazzi Avenue to Boones Ferry Rd)

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions



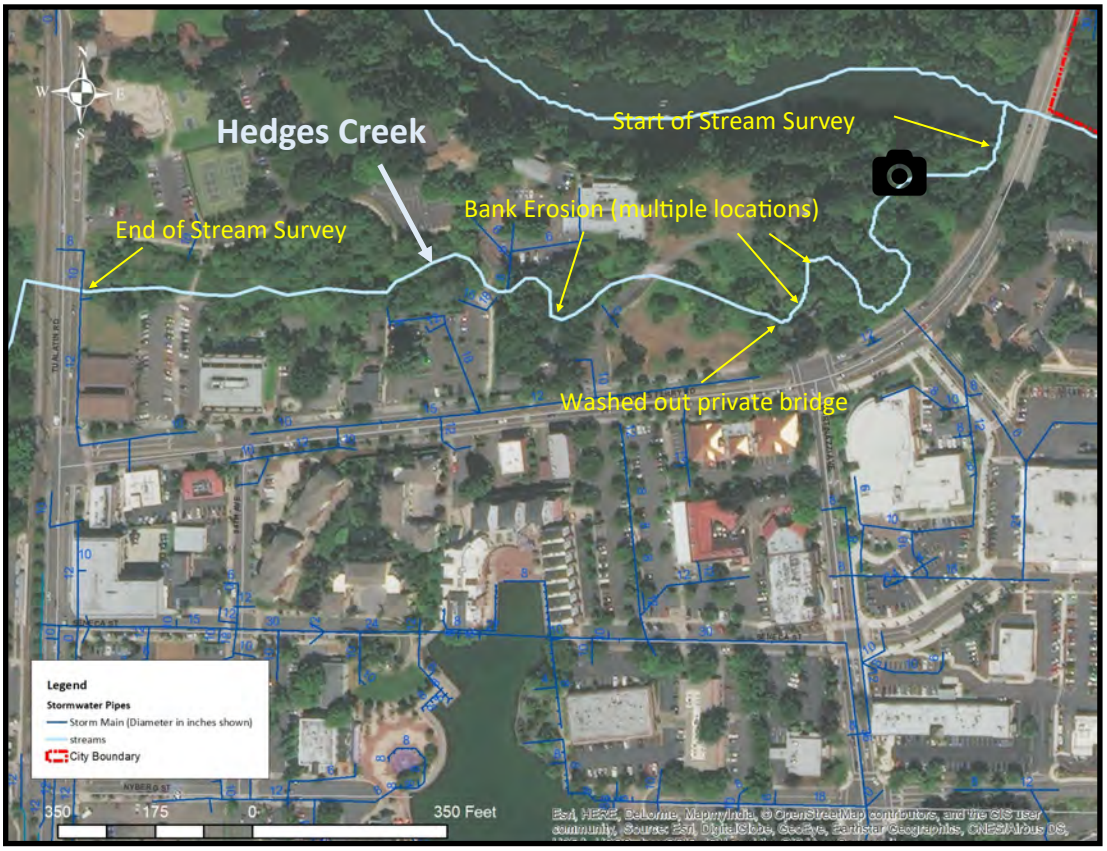


Generalized topographic valley cross section of Nyberg Creek between Tonka Rd. and Boones Ferry Rd.

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions

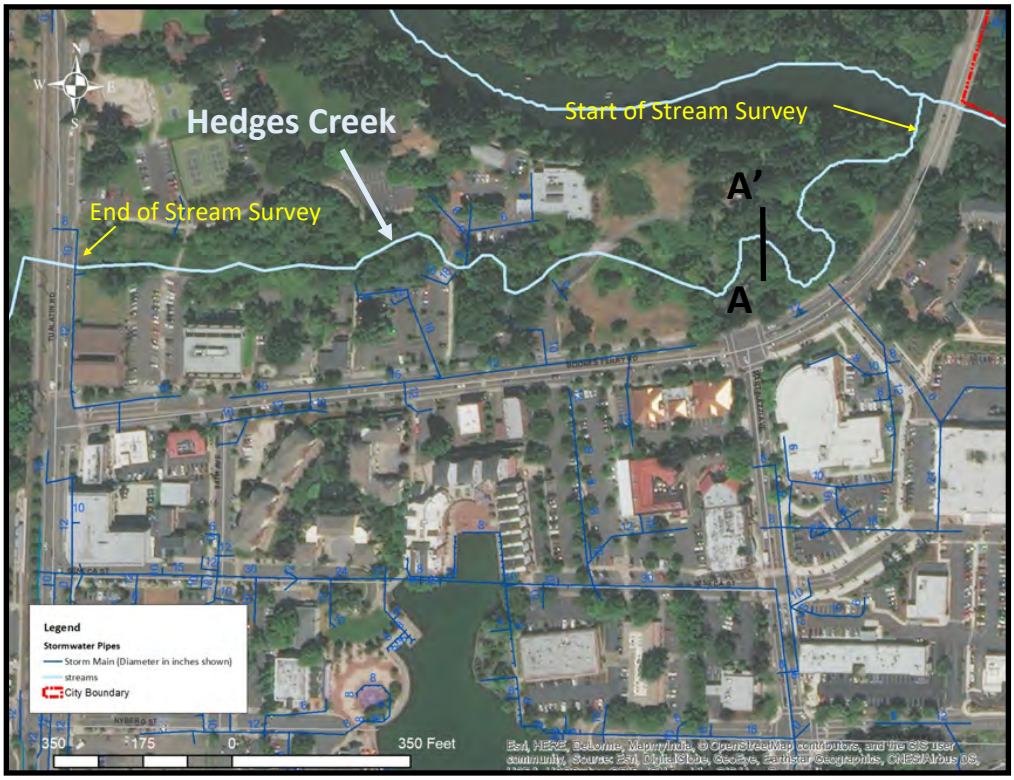
Channel-spanning debris jam in Hedges Creek Reach #1 approx. 300' upstream of Tualatin River (photo location shown below with camera icon)

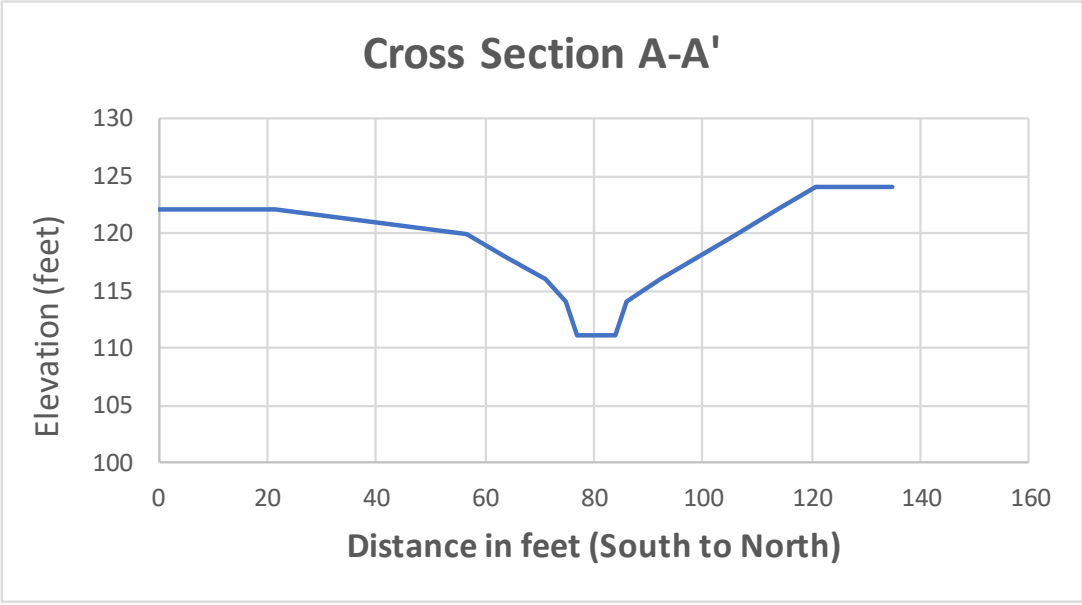
Stream	Hedges Creek
Reach	#1 (Tualatin River to Tualatin Rd)
General Characteristics	
Reach Length:	~2,250 ft.
Gradient:	~0.8%
Valley Width:	~75-125'
Planform:	Meandering and straight, where confined
Average BFW:	~11.5' (wider near Tualatin, channel narrows upstream)
Average BFD:	~4.2'
Substrate:	Varies. Gravel and large rocks near mouth, hard silt in straight sections.
Vegetation:	Conifer and deciduous trees in lower section, reed canary grass, nettles, blackberries.
Beaver Activity:	Yes, upper half of reach.
Issues:	Bank erosion near private property. Washed out private bridge. No City issues.



Aerial view of Hedges Creek Reach #1 (Tualatin River to Tualatin Rd.)

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions





Generalized topographic valley cross section of Hedges Creek Reach #1.

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions

Typical photo of Hedges Creek Reach #2. Stream channel is overgrown with invasive vegetation. Channel is to the right and 4' below Ryan (standing on the bank). Photo location shown below with camera icon.

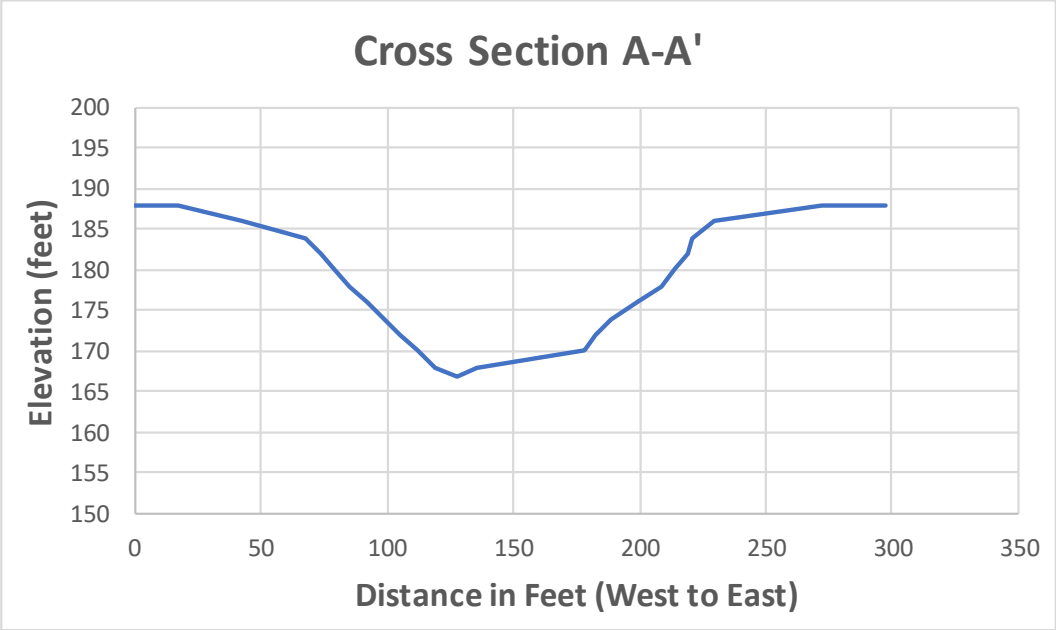
Stream	Hedges Creek
Reach	#2 (Tualatin-Sherwood Rd. to Industrial Way)

General Characteristics

Reach Length:	~1,900 ft.
Gradient:	~0.2%
Valley Width:	~125-250'
Planform:	Meandering
Average BFW:	~11.5'
Average BFD:	~4.3'
Substrate:	Clay, hard silt.
Vegetation:	Reed canary, blackberries, nightshade, jewel weed, some deciduous and conifer trees.
Beaver Activity:	Yes, one beaver dam noted.
Issues:	Invasive vegetation.

Aerial view of Hedges Creek Reach #2 (Tualatin-Sherwood Rd to Industrial Way)

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions



Generalized topographic valley cross section of Hedges Creek Reach #2.

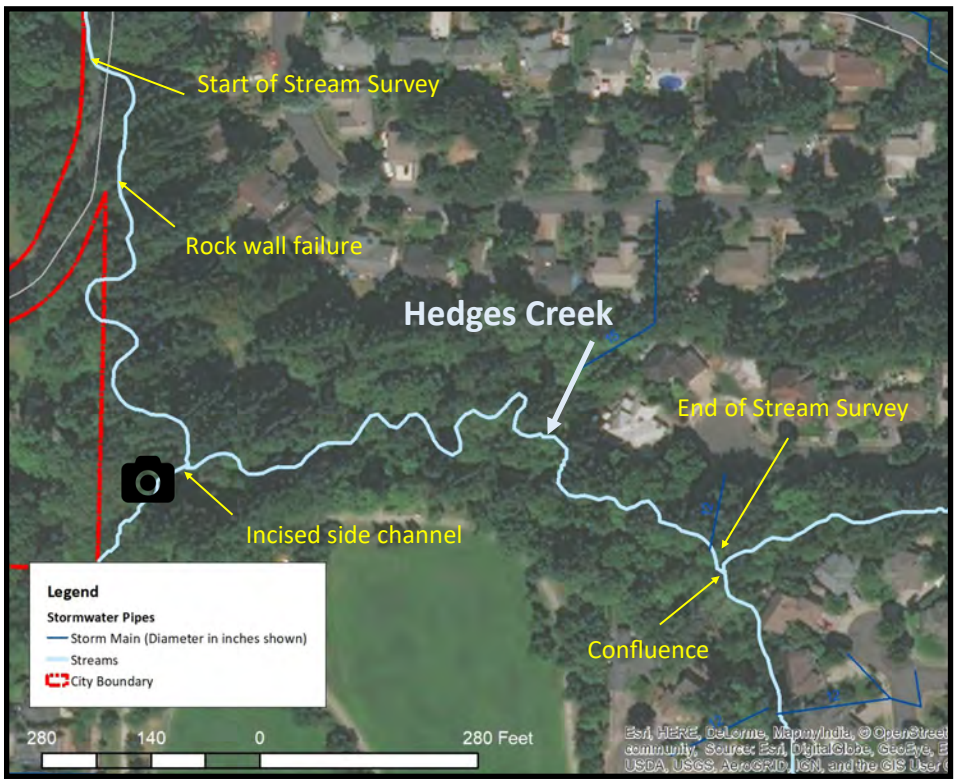
City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions

Incised side channel of Hedges Creek. Photo location shown below with camera icon.

Stream	Hedges Creek
Reach	#3A (Blake St/105th St to Confluence with S. Tributary)

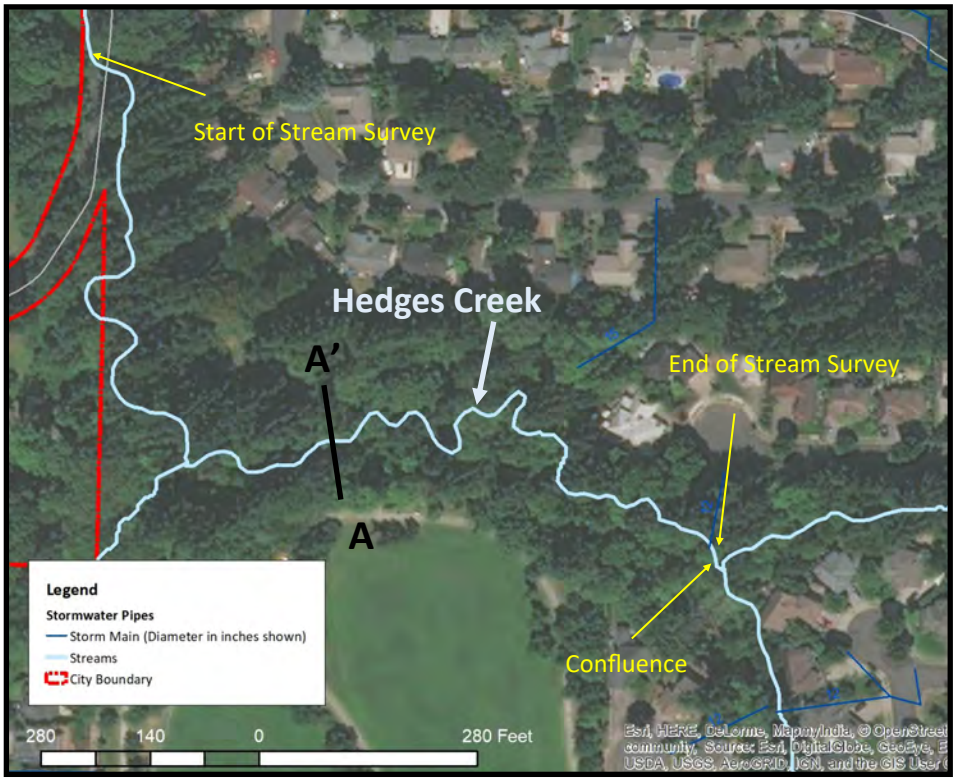
General Characteristics

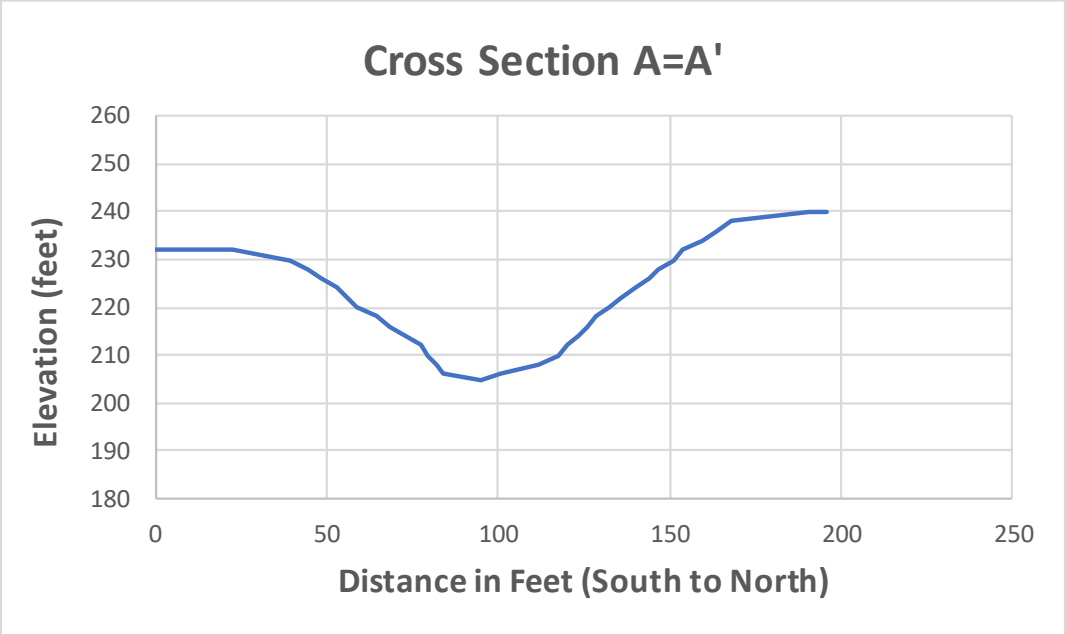
Reach Length:	~1,740 ft.
Gradient:	~0.9 %
Valley Width:	~50-150’
Planform:	Meandering and straight (where steep and confined)
Average BFW:	~10.5’
Average BFD:	~3.6’
Substrate:	Varies. Hard silt, bedrock, gravel, and loose silt.
Vegetation:	Conifer and deciduous trees, reed canary grass, nettles, blackberries.
Beaver Activity:	None observed.
Issues:	Channel incision adjacent to sanitary sewer manhole, and bank erosion and rock wall failure adjacent to Blake St./105th St.



Aerial view of Hedges Creek Reach #3 (Blake St/105th St to Confluence with S. Tributary)

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions





Generalized topographic valley cross section of Hedges Creek Reach #3 downstream of confluence.

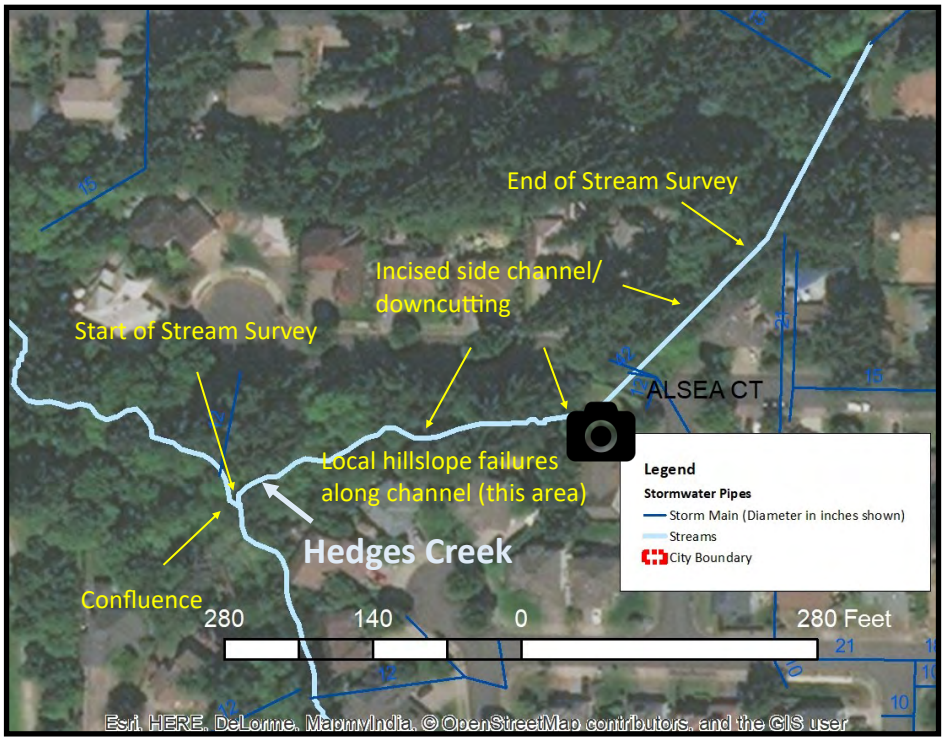
City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions

Unstable hillslope and debris in channel. Photo Location shown below with camera icon.

Stream	Hedges Creek
Reach	#3B (Confluence with S. Tributary to SW 99th Ave)

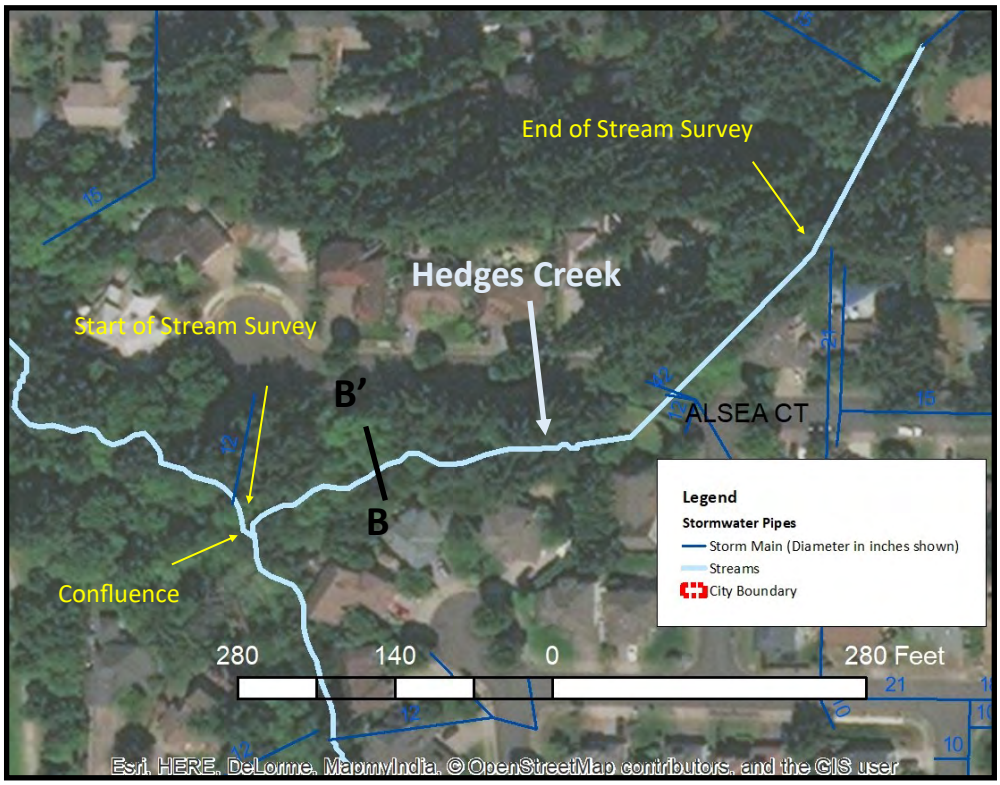
General Characteristics

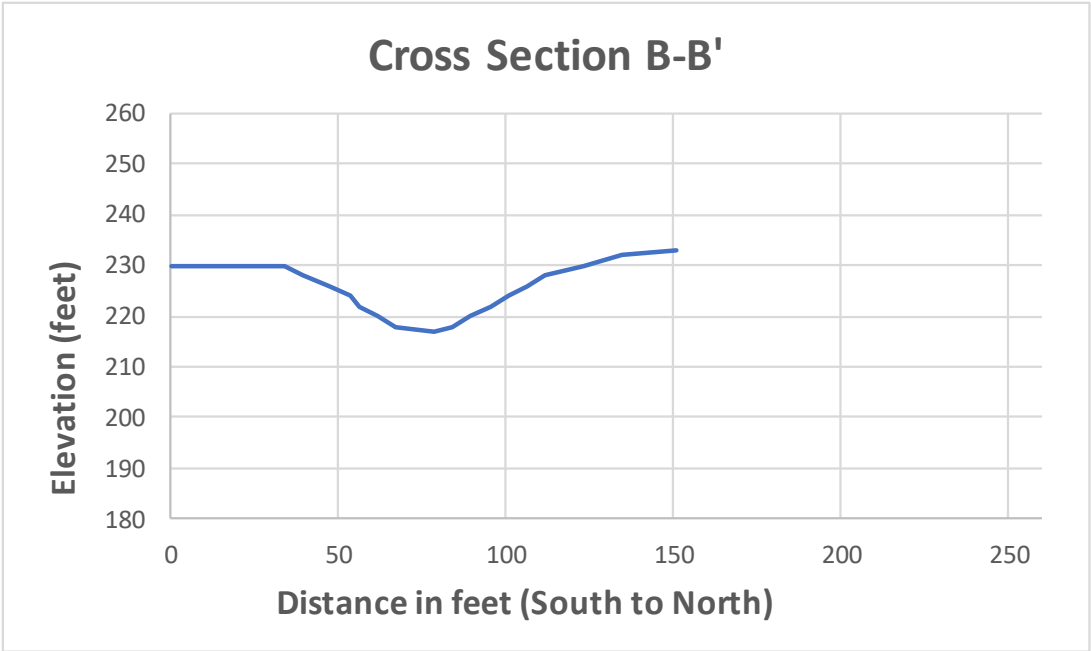
Reach Length:	~560 ft.
Gradient:	~3.7%
Valley Width:	~50-150’
Planform:	Straight
Average BFW:	5.5’
Average BFD:	2.8’
Substrate:	Varies. Hard silt, gravel, and loose silt.
Vegetation:	Conifer and deciduous trees, reed canary grass, nettles, blackberries.
Beaver Activity:	None observed.
Issues:	Extreme erosion/channel downcutting in proximity to private property, and hillslope failures.



Aerial view of Hedges Creek Reach #3B (Confluence with S. Tributary to SW 99th Avenue)

City of Tualatin
Stream Channel Condition Survey
Stream Reach Descriptions





Generalized topographic valley cross section of Hedges Creek Reach #3 upstream of confluence.

Attachment B-1

Saum Creek Reach #1 Photo Log

Attachment B-1

Photo Documentation

Saum Creek Reach #1 (Tualatin River from mouth to SW Prosperity Park Rd.)

Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are shown in the order that the stream survey was conducted, from the most downstream point in the reach to the most upstream point in the reach. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Saum Creek Reach #1 are identified as S1-X, with X being the number of the photograph. Photo locations are shown in Figure 1.

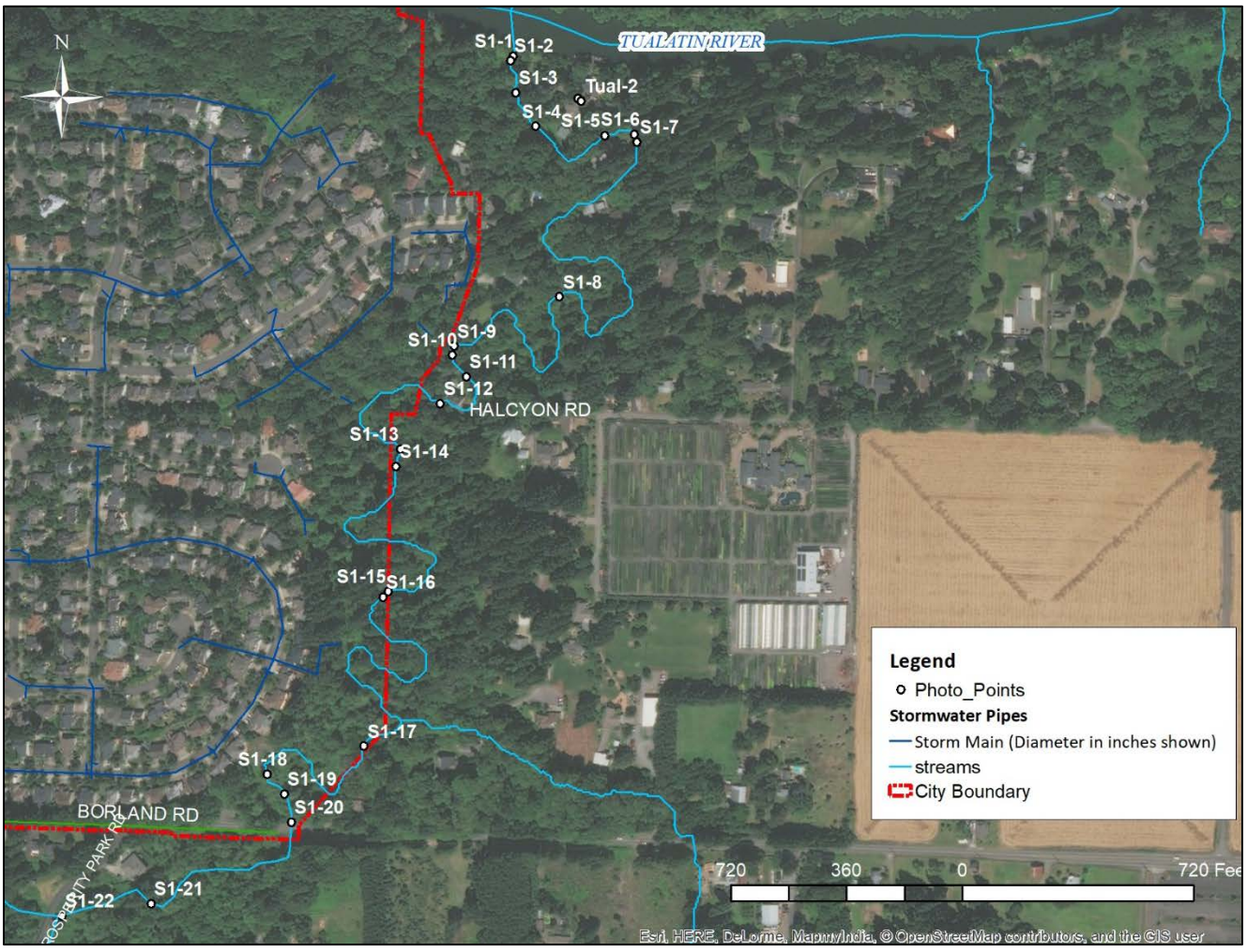
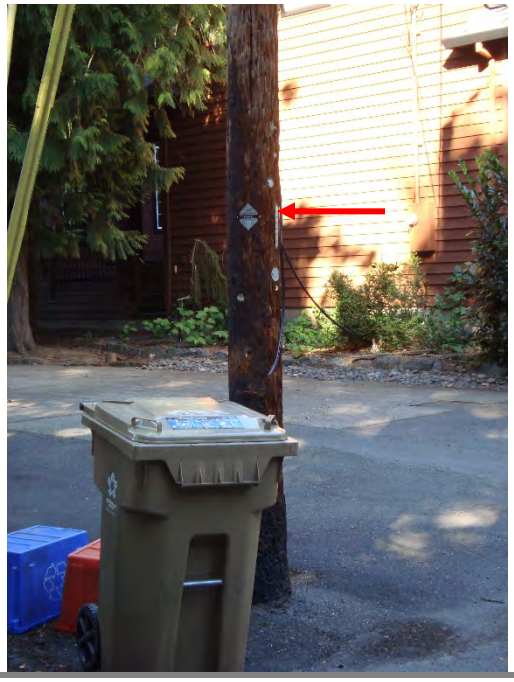


Figure 1. Saum Creek Reach #1 Photo Location Points



Site location: Near Tualatin River
Photo number: Tual-1
Description: Flood marker on utility pole (1996 flood). Red arrow shows marker location.

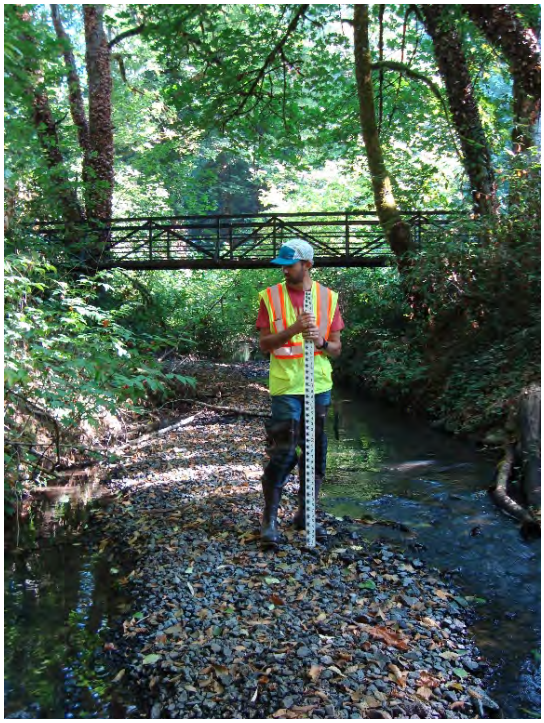
Site location: Near Tualatin
Photo number: Tual-2
Description: View of utility pole with flood marker (1996 flood). Red arrow shows marker location.

Site location: Tualatin River
Photo number: S1-1
Description: Tualatin River from mouth of Saum Creek- looking north

Site location: 30' upstream
Photo number: S1-2
Description: 7' high vertical bank (right bank) unstable, bamboo

Site location: ~200' upstream from Tualatin
Photo number: S1-3
Description: Former bridge abutment, looking upstream at left bank

Site location: ~400' upstream from Tualatin River
Photo number: S1-4
Description: Corrugated steel pipe (former water intake?) on left bank



Site location: ~750' upstream from Tualatin

Photo number: S1-5

Description: Gravel deposition in bed (angular rock, construction debris?), pedestrian bridge in background, looking upstream

Site location: ~800' upstream of Tualatin

Photo number: S1-6

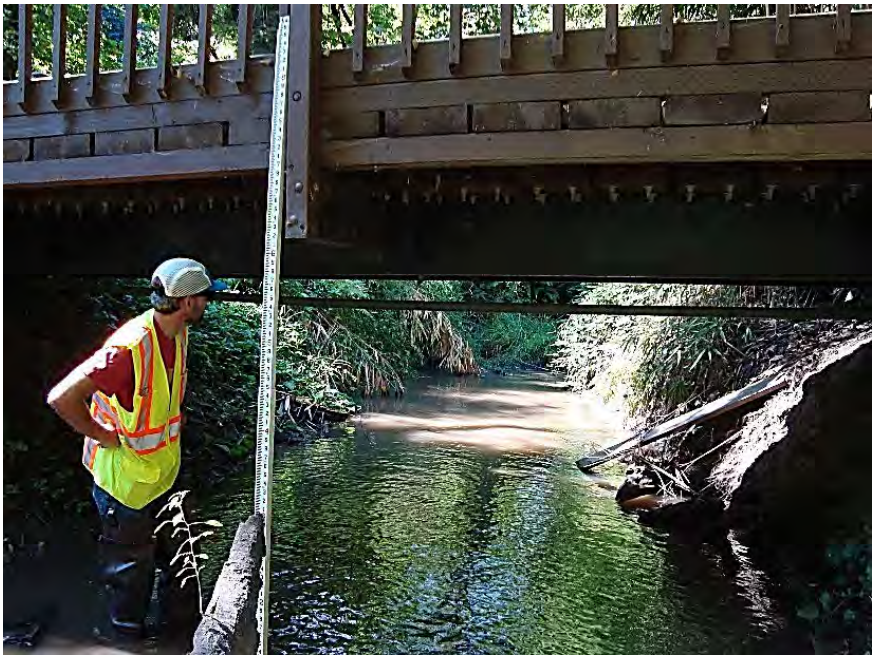
Description: Private driveway culvert crossing (6'), looking upstream

Site location:	~850' upstream of Tualatin, 20' upstream of culvert
Photo number:	S1-7
Description:	Old 3' high concrete weir wall (2 ½' wide opening) with pool on downstream end. Weir is leaning downstream and sediment has deposited behind it on upstream side.

Site location:	~800' downstream of SW Halcyon Rd. culvert crossing
Photo number:	S1-8
Description:	Silty bottom, water depth 1 ½' – 2', bankfull width ~ 12', bankfull depth ~ 6'

Site location: SW Halcyon Rd. culvert crossing
Photo number: S1-9
Description: Looking upstream- twin 6' culverts, plunge pool on downstream end

Site location: 20' upstream of SW Halycon Rd. crossing
Photo number: S1-10
Description: Channel looking downstream



Site location: Driveway bridge ~150' upstream of SW Halcyon Rd.
Photo number: S1-11
Description: Looking downstream

Site location: ~300' upstream of SW Halycon Rd.
Photo number: S1-12
Description: Looking upstream at pedestrian bridge, large wood in channel in distance

Site location: 800’ upstream from SW Halcyon Rd.

Photo number: S1-13

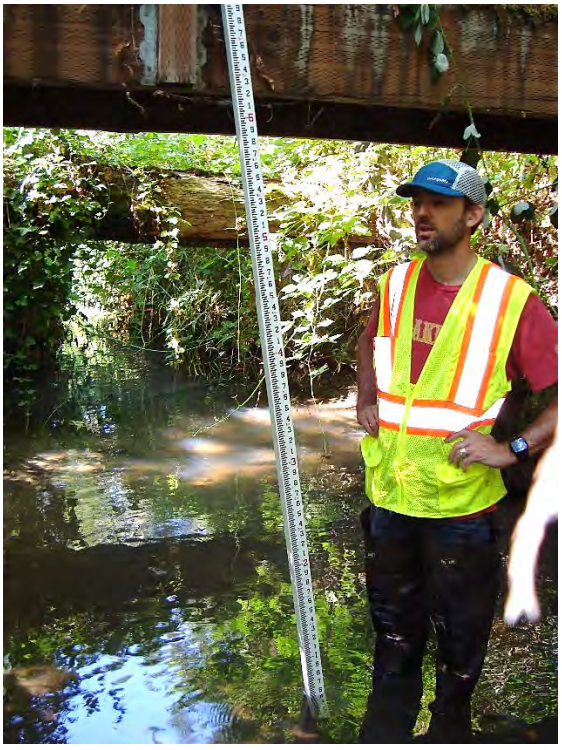
Description: Slightly more gravel in channel in this reach

Site location: 850’ upstream from SW Halcyon Rd.

Photo number: S1-14

Description: Looking upstream at beaver dam, debris on branches (high water mark near Ryan’s right hand ~4.5 feet above channel bed)

Site location: ~1,200' downstream from SW Borland Rd.
Photo number: S1-15
Description: Pedestrian bridge looking upstream, silty bed



Site location: ~1,200' downstream from SW Borland Rd.
Photo number: S1-16
Description: Pedestrian bridge looking downstream, large tree down across channel in distance

Site location: ~700' downstream of SW Borland Rd.

Photo number: S1-17

Description: Beaver dam, ivy-covered trees in distance, looking upstream

Site location: 300' downstream of SW Borland Rd.

Photo number: S1-18

Description: Riprap left bank outside bend

Site location: 150' downstream of SW Borland Rd.
Photo number: S1-19
Description: Left bank slump, seepage, wetland plants observed in vicinity

Site location: SW Borland Rd. culvert
Photo number: S1-20
Description: Looking upstream (10 1/2 'high, 10' wide)

Site location: 600' upstream of SW Borland Rd.
Photo number: S1-21
Description: Broken pipe (right side of photo) on left bank, looking upstream

Site location: SW Prosperity Park Rd culverts
Photo number: S1-22
Description: Looking upstream at twin 36" culverts

Attachment B-2

Saum Creek Reach #2 Photo Log

Attachment B-2

Photo Documentation

Saum Creek Reach #2 (SW Lee Street to SW 65th Avenue)

Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are shown in the order that the stream survey was conducted, from the most downstream point in the reach to the most upstream point in the reach. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Saum Creek Reach #2 are identified as S2-X, with X being the number of the photograph. Photo locations are shown in Figure 1.

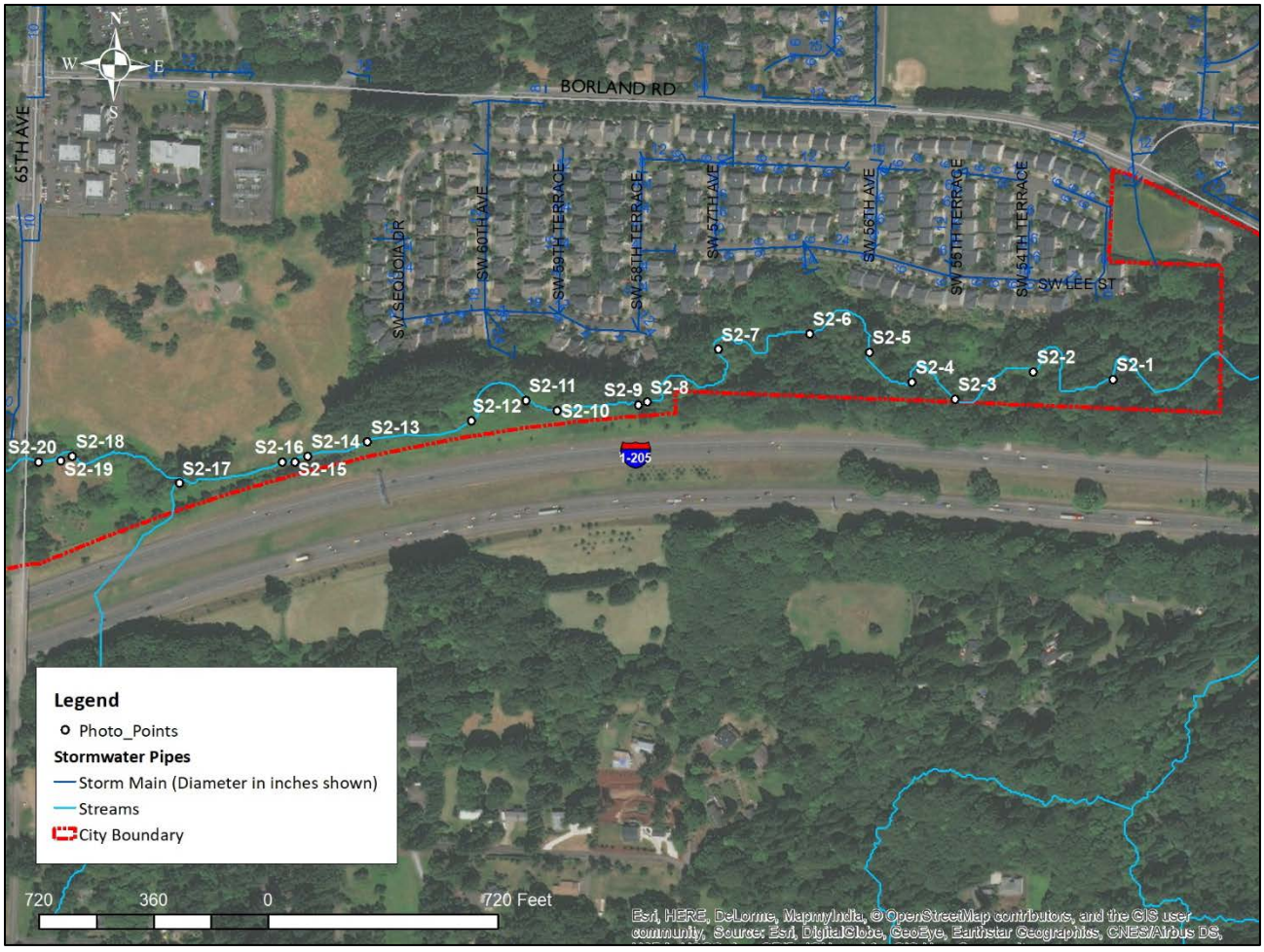


Figure 1. Saum Creek Reach #2 Photo Location Points

Site location: 50’ upstream of SW Lee St. (starting location)
Photo number: S2-1
Description: Hard silt on bottom of channel, creates riffles, looking upstream

Site location: South of SW 45th Terrace
Photo number: S2-2
Description: Looking upstream

Site location: South of SW 55th Terrace
Photo number: S2-3
Description: Wide floodplain bench left bank (right side of photo)

Site location: Between SW 55th and SW 56th, near I-205
Photo number: S2-4
Description: Channel spanning debris blockage, ~4' above channel bed, looking south and upstream

Site location: South of SW 56th
Photo number: S2-5
Description: Looking upstream, facing north, cedar tree on left bank appears to shade out invasive plants

Site location: Between SW 56th and SW 57th
Photo number: S2-6
Description: Hard silt creates pool/drop sequence in channel, small riffles

Site location: South of SW 57th
Photo number: S2-7
Description: Looking upstream at debris in channel and associated bank erosion on edges

Site location: South of SW 58th, near trail project under construction
Photo number: S2-8
Description: Looking downstream, hard clay unit in bed, slight knick point in channel, minor incision just upstream of debris jam

Site location: South of SW 58th, near trail project under construction

Photo number: S2-9

Description: Looking upstream- same location as Photo S2-8

Site location: South of SW 59th

Photo number: S2-10

Description: Location of 12" steel pipe in channel disconnected from vertical segment. Some gravel in channel at this location.

Site location: Upstream of Photo S2-10
Photo number: S2-11
Description: Groundwater seepage on right bank

Site location: South of Sequoia Drive
Photo number: S2-12
Description: Debris jam

Site location: 1200' east of SW 65th Ave.
Photo number: S2-13
Description: Fence, looking west

Site location: 1000' east of SW 65th Ave.
Photo number: S2-14
Description: Mitigation site on right bank (I-205 side), left side of photo. Red arrow shows channel location.

Site location: 1000' east of SW 65th Ave.
Photo number: S2-15
Description: Looking east (downstream) at mitigation site. Red arrow shows channel location.

Site location: 1000' east of SW 65th Ave.
Photo number: S2-16
Description: Looking north at construction site across channel

Site location: 600' east of SW 65th Ave.
Photo number: S2-17
Description: Right bank swale on west side of mitigation area.

Site location: 100' east of SW 65th Ave.
Photo number: S2-18
Description: Debris jam looking downstream

Site location: 100' east of SW 65th Ave
Photo number: S2-19
Description: Looking upstream from same location as Photo S2-18. Gravel in channel at this point.

Site location: SW 65th Ave. crossing
Photo number: S2-20
Description: Looking upstream at pool on downstream side of SW 65th Ave.

Attachment B-3

Saum Creek Reach #3 Photo Log

Attachment B-3

Photo Documentation

Saum Creek Reach #3 (Vicinity of SW Blake St.)

Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are shown in the order that the stream survey was conducted, from the most downstream point in the reach to the most upstream point in the reach. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Saum Creek Reach #3 are identified as S3-X, with X being the number of the photograph. Photo locations are shown in Figure 1.

Figure 1. Saum Creek Reach #3 Photo Location Points

Site location: Downstream of SW Blake St.
Photo number: S3-1
Description: Looking down at valley bottom from above. Red arrow indicates location of channel.

Site location: Downstream of SW Blake St.
Photo number: S3-2
Description: Hillslope failure and perched culvert

Site location: Downstream of SW Blake St.
Photo number: S3-3
Description: Perched culvert- hillslope failure on left bank

Site location: Upstream of SW Blake St. crossing
Photo number: S3-4
Description: Beginning of restoration area, very wet

Site location:	~80' upstream of SW Blake St.
Photo number:	S3-5
Description:	Looking upstream, mucky conditions

Site location:	~130' upstream of SW Blake St.
Photo number:	S3-6
Description:	Looking downstream, swale on right bank, rock on outside bend (near stadia- obscured by vegetation)

Site location: ~300' upstream of SW Blake St.
Photo number: S3-7
Description: Constructed rock drop pool (restoration)

Site location: ~350' upstream of SW Blake St.
Photo number: S3-8
Description: Constructed rock pool

Attachment B-4

Nyberg Creek Reach #1 Photo Log

Attachment B-4

Photo Documentation

Nyberg Creek Reach #1 (SW Nyberg Lane to SW 65th Ave.)

Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are shown in the order that the stream survey was conducted, from the most downstream point in the reach to the most upstream point in the reach. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Nyberg Creek Reach #1 are identified as N1-X, with X being the number of the photograph. Photo locations are shown in Figure 1.

Figure 1. Nyberg Creek Reach #1 Photo Location Points

Site location: South side of SW Nyberg Lane
Photo number: N1-1
Description: Ponded area adjacent to Nyberg Creek upstream of SW Nyberg Lane

Site location: Upstream side of SW Nyberg Lane
Photo number: N1-2
Description: Nyberg Creek where it flows under SW Nyberg Lane through three 48" culverts

Site location:	Upstream side of SW Nyberg Lane
Photo number:	N1-3
Description:	Looking downstream at culverts, same location as Photo N1-2

Site location:	200’ upstream from SW Nyberg Lane
Photo number:	N1-4
Description:	Old roadbed. Stream is in 30” CMP culvert under road.

Site location: 250’ upstream of SW Nyberg Lane

Photo number: N1-5

Description: Deep, narrow main channel, flow is spread-out in multiple paths across wetland area

Site location: 400’ upstream of SW Nyberg Lane

Photo number: N1-6

Description: Looking downstream at top of beaver dam. Red arrow points to top of dam. Drop is approximately 3 feet.

Site location: 450' upstream of SW Nyberg Lane
Photo number: N1-7
Description: Recently removed beaver debris

Site location: 300' downstream of SW 65th Ave.
Photo number: N1-8
Description: Looking upstream at ponded area. Red arrow shows location of SW 65th Ave.

Site location: 100' downstream of SW 65th Ave.
Photo number: N1-9
Description: Upstream end of ponded area

Site location: Nyberg Creek on downstream side of SW 65th Ave.
Photo number: N1-10
Description: Same view as Photo N1-9

Site location:	Nyberg Creek on downstream side of SW 65th Ave.
Photo number:	N1-11
Description:	Photo taken from left bank (north side) on 9/12. Additional debris was removed between 9/11 and 9/12. See photo N1-12 for comparison.

Site location:	Nyberg Creek on downstream side of SW 65th Ave (east side)
Photo number:	N1-12
Description:	Photo taken from south side on 9/11. Red arrow shows debris removed from beaver activity.

Attachment B-5

Nyberg Creek Reach #2 Photo Log

Attachment B-5

Photo Documentation

Nyberg Creek Reach #2 (Downstream of I-5, wetland area)

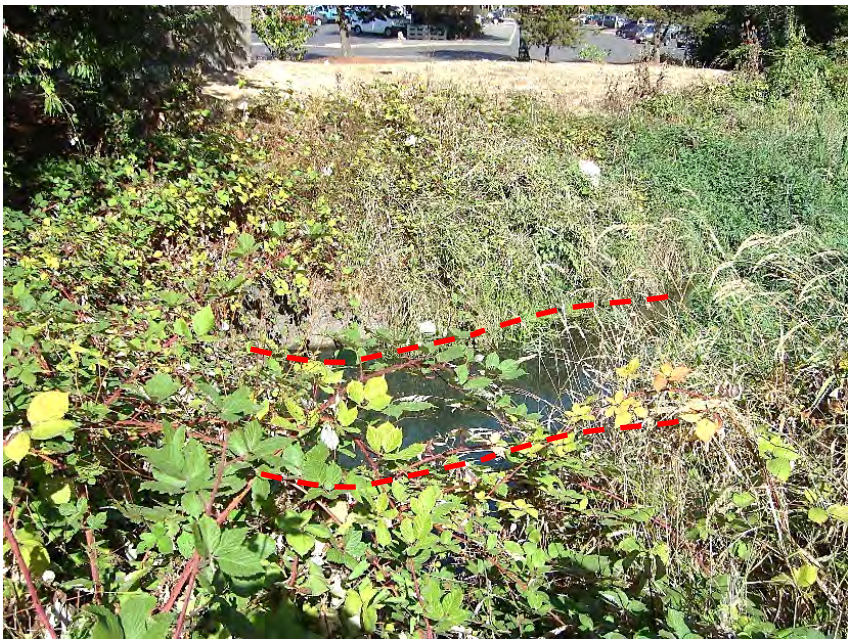
Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are shown in the order that the stream survey was conducted, from the most downstream point in the reach to the most upstream point in the reach. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Nyberg Creek Reach #2 are identified as N2-X, with X being the number of the photograph. Photo locations are shown in Figure 1.

Figure 1. Nyberg Creek Reach #2 Photo Location Points

Site location: South of 7-11, West of SW 65th Ave.
Photo number: N2-1
Description: Nyberg Creek Wetlands

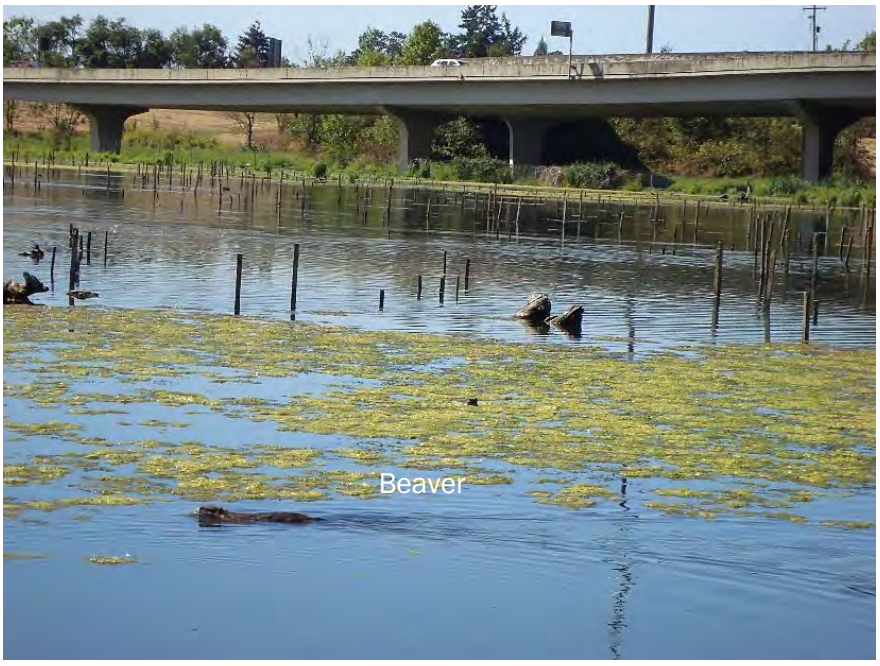
Site location: Business park between Nyberg wetlands and SW Nyberg St.
Photo number: N2-2
Description: Ponded area shown indicated by red arrow.

Site location: Nyberg Wetlands, downstream side of beaver dam
Photo number: N2-3
Description: Staff gauge in ponded area



Site location: South of business park
Photo number: N2-4
Description: Constructed channel opening on north side of beaver dam (shown by red dashed lines)

Site location: Downstream side of beaver dam
Photo number: N2-5
Description: Dam extends the entire length of valley bottom, creating a ~3 – 4' drop



Site location: Ponded area downstream of I-5
Photo number: N2-6
Description: Baby beaver in foreground

Attachment B-6

Nyberg Creek Reach #3 Photo Log

Attachment B-6

Photo Documentation

Nyberg Creek Reach #3 (SW SW Martinazzi Ave. Ave. to SW Boones Ferry Rd.)

Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are shown in the order that the stream survey was conducted, from the most downstream point in the reach to the most upstream point in the reach. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Nyberg Creek Reach #3 are identified as N3-X, with X being the number of the photograph. Photo locations are shown in Figure 1.

Figure 1. Nyberg Creek Reach #3 Photo Location Points

Site location: East side of SW SW Martinazzi Ave.

Photo number: N3-1

Description: Looking downstream of SW Martinazzi Ave. where 48-inch diameter stormwater pipe enters Nyberg Creek (approximately where red arrow is pointing)

Site location: Upstream of SW Martinazzi Ave. by Shari's restaurant

Photo number: N3-2

Description: Nyberg Creek, concrete dam with notch

Site location: ~200' upstream of SW Martinazzi Ave.
Photo number: N3-3
Description: Culvert next to Shari's restaurant in parking lot (indicated by red arrow)

Site location: ~300' upstream from SW Martinazzi Ave.
Photo number: N3-4
Description: Looking at the upstream end of the culvert next to Shari's restaurant (shown by red arrow)

Site location: ~350' upstream from SW Martinazzi Ave.

Photo number: N3-5

Description: Looking downstream from footbridge at upstream end of parking lot culvert (obscured by reed canary grass)

Site location: SW Tonka Rd. bridge

Photo number: N3-6

Description: Looking in downstream direction

Site location: ~400' downstream of SW Boones Ferry Rd.
Photo number: N3-7
Description: Looking upstream, narrow channel

Site location: ~200' downstream of SW Boones Ferry Rd.
Photo number: N3-8
Description: 42" outfall on south side of channel (1/2 full)

Site location: 100' downstream of SW Boones Ferry Rd.
Photo number: N3-9
Description: Looking upstream at narrow channel. Grass has been cut on north side.

Site location: SW Boones Ferry Rd.
Photo number: N3-10
Description: Culverts entering Nyberg Creek from SW Boones Ferry Rd.

Attachment B-7

Hedges Creek Reach #1 Photo Log

Attachment B-7

Photo Documentation

Hedges Creek Reach #1 (Tualatin River to SW Tualatin Rd.)

Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are shown in the order that the stream survey was conducted, from the most downstream point in the reach to the most upstream point in the reach. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Hedges Creek Reach #1 are identified as H1-X, with X being the number of the photograph. Photo locations are shown in Figure 1

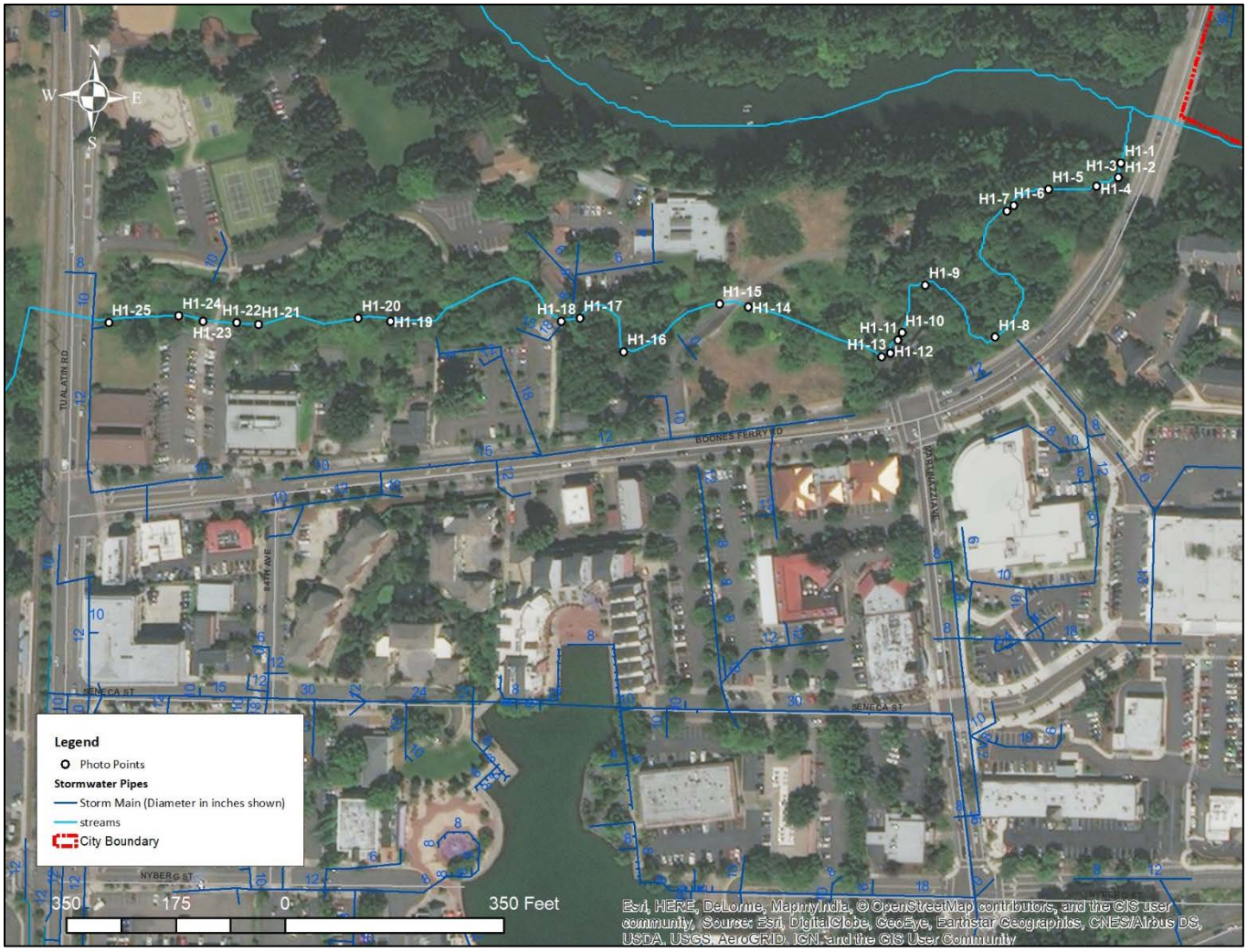


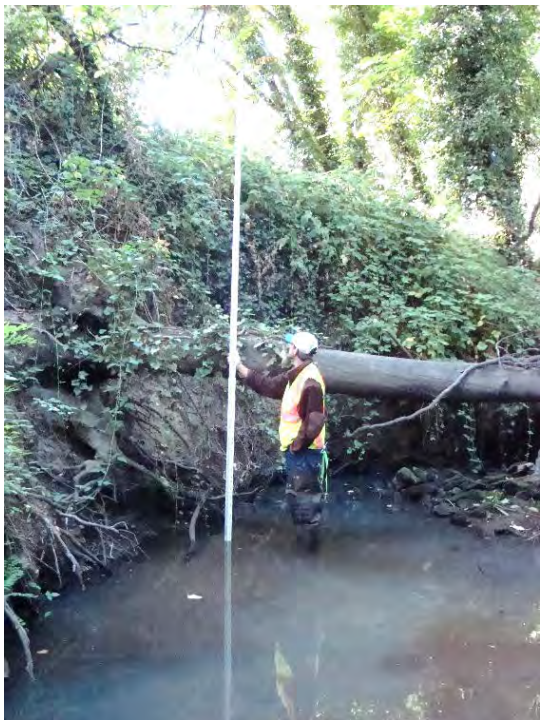
Figure 1. Hedges Creek Reach #1 Photo Location Points

Waterbody:	**Hedges Creek Reach #1**
Reach description:	
Site locations:	**Tualatin River to Tualatin Road**

Site location: Mouth of Hedges Creek below Boones Ferry Road bridge at Tualatin River
Photo number: H1-1
Description: 3" to 1.5' rocks in channel (rip-rap stabilization)

Site location: 30' upstream of Tualatin River
Photo number: H1-2
Description: 1' – 2' rocks in channel, high water mark on bridge abutment corresponds to about 6' above channel bed in this location, steep gradient to mouth

Site location: 100' upstream of Tualatin River
Photo number: H1-3
Description: Lots of silt in channel, gradient flattens



Site location: 150' upstream of Tualatin River
Photo number: H1-4
Description: Looking upstream, right bank erosion, downed trees, slumping on right bank

Site location: 200’ upstream of Tualatin River
Photo number: H1-5
Description: Concrete poured in channel from left bank

Site location: 300’ upstream of Tualatin River
Photo number: H1-6
Description: Looking upstream, gravel deposit in center of channel below channel-spanning debris jam

Site location: 300' upstream of Tualatin River
Photo number: H1-7
Description: Looking downstream at debris jam, Ryan is touching water line (?) pipe across debris

Site location: 350' upstream of Tualatin River
Photo number: H1-8
Description: Looking upstream at outside bend (adjacent to SW Boones Ferry Road)

Site location: 450’ upstream of Tualatin River
Photo number: H1-9
Description: Looking upstream, bank armoring on left bank (right side of photo)

Site location: 500’ upstream of Tualatin River (near SW Martinazzi Avenue)
Photo number: H1-10
Description: Debris deposited downstream of washed out driveway bridge

Site location: 500' upstream of Tualatin River

Photo number: H1-11

Description: Looking downstream at debris and creek, right bank (outside bend) is downstream of culvert constriction (washed out) where flow is concentrated. This area is vulnerable to erosion.

Site location: 500' upstream of Tualatin River

Photo number: H1-12

Description: Looking upstream at culvert under washed out bridge amongst debris that has not been removed

Site location: 500’ upstream of Tualatin River
Photo number: H1-13
Description: Channel upstream of washed out bridge, stagnant water. Flow is restricted by debris and washed out culvert.

Site location: 800’ upstream of Tualatin River
Photo number: H1-14
Description: Looking east (downstream) from new bridge.

Site location: 800' east of Tualatin River
Photo number: H1-15
Description: Looking west (upstream) from new bridge.

Site location: 1,000' upstream of Tualatin River
Photo number: H1-16
Description: Old culvert (where Ryan is standing), photo is looking upstream at outside bend where stream takes a sharp turn to the north

Site location: 1,200' upstream of Tualatin River
Photo number: H1-17
Description: Tualatin-Greenway bridge, channel choked with reed canary grass

Site location: 1,200' upstream of Tualatin River
Photo number: H1-18
Description: Same location as photo H1-17. 18" diameter stormwater pipe enters channel on right bank where stadia rod is pointed.

Site location: 1400’ upstream of Tualatin River
Photo number: H1-19
Description: Looking upstream at reed canary grass choked channel.

Site location: 1450’ upstream of Tualatin River
Photo number: H1-20
Description: Beaver dam looking upstream, wider floodplain west of this location (open space).

Site location: 1,500' upstream of Tualatin River
Photo number: H1-21
Description: Looking downstream in open space area.

Site location: 200' downstream of SW Tualatin Road
Photo number: H1-22
Description: Pedestrian bridge in wetland area downstream of SW Tualatin Road.

Site location:	200' downstream of SW Tualatin Road
Photo number:	H1-23
Description:	Looking upstream from pedestrian bridge at pooled water in wetland area east of SW Tualatin Road.

Site location:	200' downstream of SW Tualatin Road
Photo number:	H1-24
Description:	Wetland area from pedestrian bridge

Site location:	SW Boones Ferry Road
Photo number:	H1-25
Description:	Looking upstream at culvert under SW Boones Ferry Road

Attachment B-8

Hedges Creek Reach #2 Photo Log

Attachment B-8

Photo Documentation

Hedges Creek Reach #2 (SW Tualatin-Sherwood Rd. to SW Industrial Way)

Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are shown in the order that the stream survey was conducted, from the most downstream point in the reach to the most upstream point in the reach. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Hedges Creek Reach #2 are identified as H2-X, with X being the number of the photograph. Photo locations are shown in Figure 1.

Figure 1. Hedges Creek Reach #2 Photo Location Points

Site location: Culvert at SW Tualatin-Sherwood Road
Photo number: H2-1
Description: Armored channel with rip-rap, looking downstream

Site location: 100' upstream of SW Tualatin-Sherwood Road
Photo number: H2-2
Description: Staff gauge in channel

Site location: 200' upstream of SW Tualatin-Sherwood Road
Photo number: H2-3
Description: Right bank outfall

Site location: 400' upstream of SW Tualatin-Sherwood Rd.
Photo number: H2-4
Description: Looking upstream, wide floodplain, banks 4- 5' high, width ~ 8 – 10 ', hard silt bed

Site location: 500' upstream of SW Tualatin-Sherwood Road
Photo number: H2-5
Description: Debris on branches above channel (~4') indicating high water mark (red arrow)

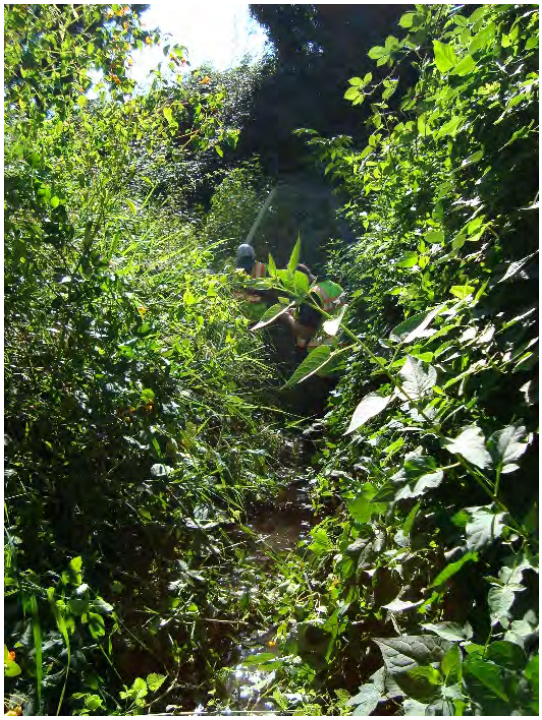
Site location: 600' upstream of SW Tualatin-Sherwood Road
Photo number: H2-6
Description: Erosion on outside bend (right bank)

Site location: 650’ upstream of SW Tualatin-Sherwood Road
Photo number: H2-7
Description: Channel location from top of bank (4’ depth). Enveloped with blackberries and reed canary grass.

Site location: 700’ upstream of SW Tualatin-Sherwood Road
Photo number: H2-8
Description: Looking upstream

Site location: 900' upstream of SW Tualatin-Sherwood Road
Photo number: H2-9
Description: Looking upstream, exposed roots in channel. Left bank debris (high water ~4')

Site location: 1000' upstream of SW Tualatin-Sherwood Road
Photo number: H2-10
Description: Looking upstream, wide floodplain



Site location: 1200' upstream of SW Tualatin-Sherwood Road
Photo number: H2-11
Description: Hard silt layer in channel

Site location: 1300' upstream of SW Tualatin-Sherwood
Photo number: H2-12
Description: Right bank erosion (red arrow)

Site location: 100' downstream from SW Industrial Way
Photo number: H2-13
Description: Rock drop pool formed by rip-rap energy dissipation at culvert outfall

Site location: Culvert at SW Industrial Way
Photo number: H2-14
Description: Looking down from right bank

Site location:	Upstream side of SW Industrial Way
Photo number:	H2-15
Description:	Fire pond #1 in-line with Hedges Creek

Attachment B-9

Hedges Creek Reach #3A Photo Log

Attachment B-9

Photo Documentation

Hedges Creek Reach #3A (SW 105th Avenue/SW Blake St. to Confluence with S. Tributary)

Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are shown in the order that the stream survey was conducted, from the most downstream point in the reach to the most upstream point in the reach. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Hedges Creek Reach #3 are identified as H3-X, with X being the number of the photograph. Photo locations are shown in Figure 1.

Hedges Creek Reach #3 was broken into two sub-reaches, #3A and #3B, to more effectively describe the unique characteristics that occur upstream and downstream of the confluence of a tributary that enters the main channel from the south downstream of SW Alsea Ct. The photos do not have a sub-reach qualifier in their name, but rather are labeled sequentially from the most downstream location to upstream location, in a similar manner to the other stream reaches assessed.

Figure 1. Hedges Creek Reach #3A Photo Location Points

Site location: Culvert under SW 105th Ave (downstream side)

Photo number: H3-1

Description: Looking upstream at SW 105th Ave. culvert crossing from west side of SW 105th Ave.

Site location: Culvert at SW 105th Ave. (upstream side)

Photo number: H3-2

Description: Looking downstream at SW 105th Ave. culvert crossing from east side of SW 105th Ave.

Site location: 30' upstream of SW 105th Ave.
Photo number: H3-3
Description: Right bank hillslope failures, wetland plants growing on slope (wet)

Site location: 150' upstream of SW 105th Ave.
Photo number: H3-4
Description: Rock wall on left bank adjacent to roadway fill

Site location: 175' upstream of SW 105th Ave.
Photo number: H3-5
Description: Left bank failure, missing wall segment adjacent to SW 105th Ave., outside bend

Site location: 500' upstream of SW 105th Ave.
Photo number: H3-6
Description: Bedrock outcrop in channel

Site location: 550' upstream of SW 105th Ave.
Photo number: H3-7
Description: Looking upstream, bedrock channel

Site location: 600' upstream of SW 105th Ave.
Photo number: H3-8
Description: Seepage on left bank, 2' above channel

Site location: 700' upstream of SW 105th Ave.
Photo number: H3-9
Description: Incised side channel on left bank, looking upstream from confluence

Site location: 750' upstream of SW 105th Ave.
Photo number: H3-10
Description: Side channel, left bank, deep incision, looking downstream

Site location: 750' upstream of SW 105th Ave.
Photo number: H3-11
Description: Side channel, adjacent to sewer manhole being eroded by channel. Manhole is 15' from start of headcut (erosion)

Site location: 750' upstream of SW 105th Ave.
Photo number: H3-12
Description: Main channel, looking upstream

Site location: 800' upstream of SW 105th Ave.
Photo number: H3-13
Description: Looking downstream at outside bend, eroding left bank

Site location: 900' upstream of SW 105th Ave.
Photo number: H3-14
Description: Outside bend erosion

Site location: 950' upstream of SW 105th Ave.
Photo number: H3-15
Description: Restoration area, looking downstream. Left bank root wads, right bank anchored log

Site location: 1100' upstream of SW 105th Ave.
Photo number: H3-16
Description: Right bank slope failure, very wet

Site location: 1300' upstream of SW 105th Ave.
Photo number: H3-17
Description: Rock in channel, moved downstream from upstream restoration project

Site location: 1350' upstream of SW 105th Ave.
Photo number: H3-18
Description: Bed protection and erosion fabric (restoration area)

Site location: 1350' upstream of SW 105th Ave.
Photo number: H3-19
Description: Looking downstream at restoration area

Site location: 400' downstream from confluence with S. Tributary
Photo number: H3-20
Description: Looking upstream, flow is coming in from right bank (very small channel not visible from left side of photo), stagnant water in this location

Site location: Immediately downstream from confluence with S. Tributary
Photo number: H3-21
Description: Looking upstream, riprap

Site location: Culvert crossing under trail
Photo number: H3-22
Description: Looking downstream, confluence with tributary from the south

Site location:	Confluence of mainstem with S. Tributary
Photo number:	H3-23
Description:	Looking upstream at south tributary

Attachment B-10

Hedges Creek Reach #3B Photo Log

Attachment B-10

Photo Documentation

Hedges Creek Reach #3B (Confluence with S. Tributary to SW 99th Ave.)

Photographs and descriptions of the field investigation (by site) are provided on the following pages. Photographs are shown in the order that the stream survey was conducted, from the most downstream point in the reach to the most upstream point in the reach. In general, photos were taken in the upstream direction, except where noted. Photographs are labeled with a unique identifier that includes photograph number and stream reach identification. Photographs in Hedges Creek Reach #3 are identified as H3-X, with X being the number of the photograph. Photo locations are shown in Figure 1.

Hedges Creek Reach #3 was broken into two sub-reaches, #3A and #3B, to more effectively describe the unique characteristics that occur upstream and downstream of the confluence of a tributary that enters the main channel from the south downstream of SW Alsea Ct. The photos do not have a sub-reach qualifier in their name, but rather are labeled sequentially from the most downstream location to upstream location, in a similar manner to the other stream reaches assessed.

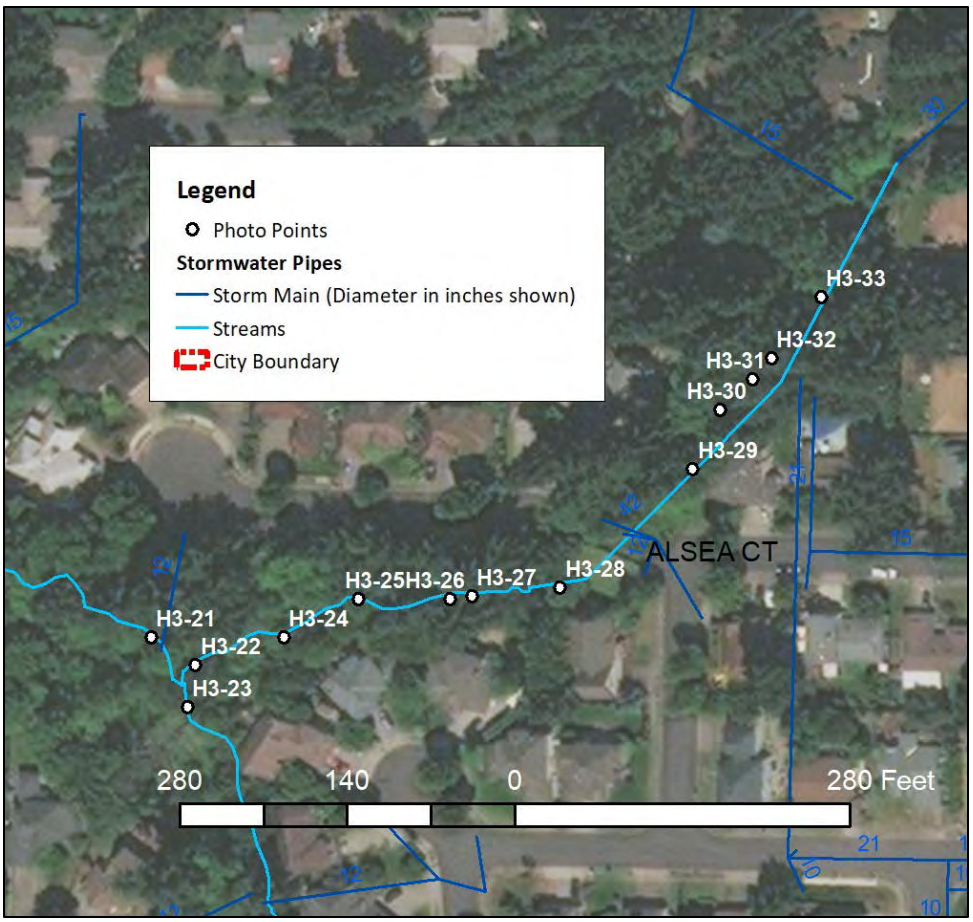


Figure 1. Hedges Creek Reach #3B Photo Location Points

Site location: Immediately downstream from confluence with S. tributary
Photo number: H3-21
Description: Looking upstream, riprap

Site location: Culvert crossing under trail
Photo number: H3-22
Description: Looking downstream, confluence with tributary from the south

Site location: Confluence with S. tributary
Photo number: H3-23
Description: Looking upstream at south tributary

Site location: 300' upstream of confluence with S. tributary
Photo number: H3-24
Description: Looking upstream, hard silt in channel, incised

Site location: 500' upstream of confluence with S. tributary
Photo number: H3-25
Description: Left bank failure, incised channel, unstable

Site location: 600' upstream of confluence with S. tributary
Photo number: H3-26
Description: Left bank slumping

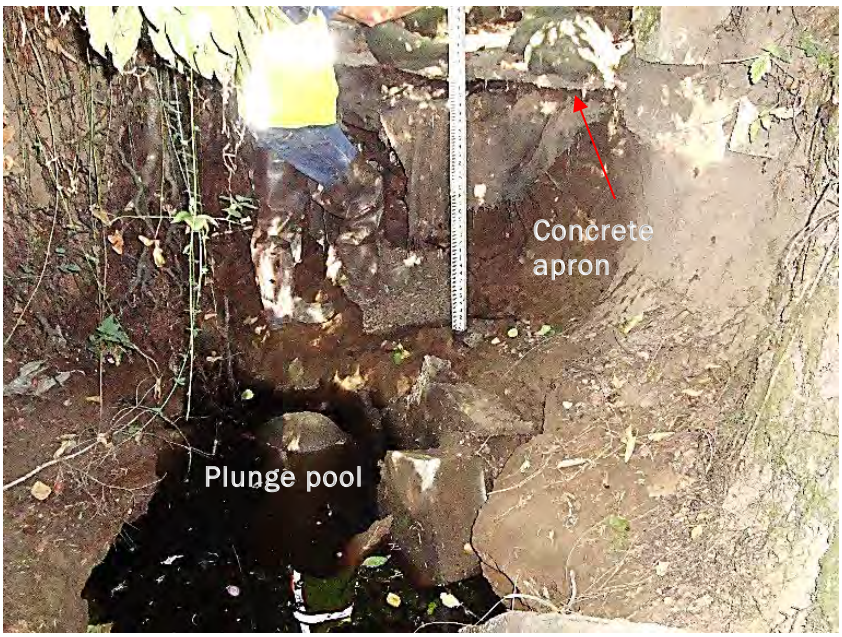
Site location: 650' upstream of confluence with S. tributary
Photo number: H3-27
Description: Left bank instability with concrete

Site location: Culvert at SW Alsea Ct.
Photo number: H3-28
Description: Looking upstream, downstream of SW Alsea Ct.. Culvert is perched. No water.

Site location: Culvert at SW Alsea Ct.
Photo number: H3-29
Description: Looking downstream, upstream of SW Alsea Ct. Dry channel.

Site location: 200' upstream of SW Alsea Ct.
Photo number: H3-30
Description: Looking upstream, narrow defined channel, dry

Site location: Culvert at 9999 SW Alsea Ct.
Photo number: H3-31
Description: Head cut below culvert, culvert is 6' above channel bottom (red arrow points to culvert)



Site location: Culvert at 9999 SW Alsea Ct.
Photo number: H3-32
Description: Plunge pool below culvert. Concrete apron below culvert indicated with red arrow.

Site location:	Culvert at 9999 SW Alsea Ct in the vicinity of SW 99th Ave.
Photo number:	H3-33
Description:	Looking downstream from upstream end of culvert. 18-inch culvert to left of 36-inch culvert.

Appendix G: CIP Detailed Cost Estimates

CIP Cost Summary

CIP ID	Project Title	Capital Expense Total (including contingency)	Engineering and Permitting	Administration	Other fees (studies, mitigation)	Capital Project Implementation Cost Total	Priority Projects (per City)		SDC Eligability[b]	SDC Percentage	SDC Eligible Cost
1	Manhassat Storm System Improvements	$1,171,000	$293,000	$117,000		**$1,581,000**		$0	100%	15%	$ 237,000.00
2	Nyberg Creek Stormwater Improvements - Phase I	$1,051,000	$368,000	$105,000		**$1,523,000**	X	$1,523,000	100%	19%	$ 289,000.00
2	Nyberg Creek Stormwater Improvements - Phase 2	$863,000	$302,000	$86,000		**$1,252,000**		$0	100%	19%	$ 238,000.00
2	Nyberg Creek Stormwater Improvements - Phase 3	$472,000	$118,000	$47,000		**$637,000**		$0	100%	19%	$ 121,000.00
3	Sandalwood Water Quality Retrofit	$79,000	$20,000	$8,000		**$107,000**		$0	100%	23%	$ 25,000.00
4	Mohawk Apartments Stormwater Improvements	$218,000	$55,000	$22,000		**$295,000**		$0	100%	20%	$ 59,000.00
5	Herman Road Storm System	$758,000	$189,000	$76,000		**$1,023,000**	X	$1,023,000	100%	27%	$ 276,000.00
6	Blake St Culvert Replacement	$381,000	$133,000	$38,000		**$552,000**	X	$552,000	100%	22%	$ 121,000.00
7	Boones Ferry Railroad Conveyance Improvements	$356,000	$124,000	$36,000		**$515,000**		$0	100%	21%	$ 108,000.00
8	89th Avenue Water Quality Retrofit	$209,000	$31,000	$21,000		**$262,000**		$0	100%	0%	$ -
9	125th Court Water Quality Retrofit	$165,000	$25,000	$16,000		**$206,000**		$0	100%	36%	$ 74,000.00
10	93rd Avenue Green Street	$166,000	$42,000	$17,000		**$224,000**		$0	100%	0%	$ -
11	Juanita Pohl Water Quality Retrofit	$116,000	$29,000	$12,000		**$156,000**	X	$156,000	100%	0%	$ -
12	Community Park Water Quality Retrofit	$117,000	$29,000	$12,000		**$158,000**	X	$158,000	100%	0%	$ -
13	Water Quality Facility Restoration - Venetia	$52,000	$8,000	$5,000		**$65,000**	X	$65,000	0%	23%	$ -
14	Water Quality Facility Restoration - Piute Court	$83,000	$12,000	$8,000		**$104,000**	X	$104,000	0%	23%	$ -
15	Water Quality Facility Restoration - Sequoia Ridge	$67,000	$10,000	$7,000		**$83,000**	X	$83,000	0%	36%	$ -
16	Water Quality Facility Restoration - Sweek Drive Pond	$83,000	$12,000	$8,000		**$103,000**	X	$103,000	0%	21%	$ -
17	Siuslaw Water Quality Facility Retrofit	$336,000	$84,000	$34,000		**$454,000**		$0	100%	23%	$ 104,000.00
18	Water Quality Facility Restoration - Waterford	$144,000	$22,000	$14,000		**$180,000**	X	$180,000	0%	22%	$ -
19	Saum Creek Hillslope Repair	$104,000	$37,000	$10,000	$20,000	**$171,000**	X	$171,000	0%	19%	$ -
20	Hedges Creek Stream Repair[a]	---	---	---		**$327,000**	X	$327,000	0%	24%	$ -
21	Nyberg Water Quality Retrofit	$1,234,000	$432,000	$123,000	$248,000	**$2,037,000**	X	$2,037,000	100%	13%	$ 265,000.00

a. Detailed costs provided in Hedges Creek (SW Ibach Road to SW 105th Avenue) Stream Assessment, CIP Opinion of Construction Costs for Identified Sites (February 2018)

b. SDC Eligibility applies to projects that increase capacity or treatment coverage. Maintenance-related projects to correct an existing deficiency are not eligible

TOTAL	**$12,015,000**	**$ 6,482,000**	**$ 1,917,000**

Unit Cost Table

Costs based on RS Means, collected bid tabs, and recent master planning efforts, adjusted to 2018 prices.

Item	Unit	Unit Cost (2018)
Inspection		
Mainline Video Inspection	FT	3.50
Earthwork		
General Earthwork/Excavation	CY	20
Embankment	CY	9
Clear and Grub brush including stumps	AC	8,200
Amended Soils and Mulch	CY	45
Jute Matting, Biodegradeable	SY	6
Tree removal	EA	300
Geomembrane	SY	30
Geotextile	SY	3
Energy dissapation pad - Rip-Rap, Class 50	CY	66
Energy dissapation pad - Rip-Rap, Class 100	CY	81
Energy dissapation pad - Rip-Rap, Class 200	CY	96
Drain Rock	CY	101
Water Quality Facility Installation		
Pond Outflow Control Structure	EA	6,100
Pond Inlet Structure	EA	4,500
Water Quality Facility Plantings with Trees	SF	6
Rain Garden	SF	27
Stormwater Planter	SF	40
Gravel Access Road	SF	5
Beehive Overflow	EA	1,500
Structure Installation		
Field Ditch Inlet	EA	4,000
Precast Concrete Manhole (48", 0-8' deep)	EA	5,600
Precast Concrete Manhole (48", 9-12' deep)	EA	6,600
Precast Concrete Manhole (48", 13-20' deep)	EA	10,200
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700
Precast Concrete Manhole (72", 0-8' deep)	EA	9,700
Precast Concrete Manhole (72", 9-12' deep)	EA	12,200
Flow Splitter/WQ Manhole (72", all depths)	EA	12,300
Contech CDS (Model CDS3025, 72")	EA	28,800
StormFilter (2-cartridge catch basin unit, 18" cartridges)	EA	10,100
Drywell (48", 20-25' deep)	EA	12,200
Curb Inlet	EA	1,300
Catch Basin, all types	EA	2,000
Concrete Fill - UIC Decomissioning	EA	10,200
Connection to Existing Lateral	EA	1,200
Connection to Existing Structure, standard	EA	2,000
Abandon Existing Pipe, no excavation (12")	FT	10
Abandon Existing Pipe, no excavation (15"-18")	FT	20
Abandon Existing Pipe, no excavation (21"-24")	FT	25
Abandon Existing Pipe, no excavation (27"-36")	FT	35
Abandon Existing Structure	EA	1,000
Demo pipe	LF	71
Remove existing pavement	SY	10
Remove Manhole Structure	EA	1,000
Plug Existing Pipe	EA	505
Check dams	EA	505
Stem wall check dam	LF	66
Headwall with wingwalls, 84" pipe	EA	14,000
Outfall Improvements	EA	3,000-10,000

Unit Cost Table

Costs based on RS Means, collected bid tabs, and recent master planning efforts, adjusted to 2018 prices.

Item	Unit	Unit Cost (2018)
Restoration/Resurfacing		
Non-Water Quality Facility Landscaping	AC	15,300
Riparian/Wetland Planting (Non-irrigated)	AC	20,300
Riparian/Wetland Planting (w/temporary irrigation)	AC	32,500
Planting and Bioengineered Restoration	SY	40
4-foot Chain Link Fence	LF	22
Split Rail Fence	LF	25
Hydroseed, large quantities	AC	2500
Seeding, small quantities (< 5,000 sf)	SF	6
Sidewalk Installation	SF	7
Trench resurfacing, Permanent ACP, 6-Inch Depth	SY	71
Concrete Curbs	FT	40
Pipe Unit Cost		
Underdrain Pipe, 4"	LF	29
Underdrain, 6" perforated HDPE	LF	56
HDPE Inlet Lead (12", 2-5' deep)	FT	91
HDPE Pipeline w/asphalt resurfacing (12", 5-10' deep)	FT	140
HDPE Pipeline w/asphalt resurfacing (12", 10-15' deep)	FT	160
HDPE Pipeline w/asphalt resurfacing (18", 5-10' deep)	FT	200
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	275
HDPE Pipeline w/asphalt resurfacing (30", 5-10' deep)	FT	325
HDPE Pipeline (30", 5-10' deep)	FT	240
HDPE Pipeline w/asphalt resurfacing (36", 5-10' deep)	FT	405
HDPE Pipeline (36", 5-10' deep)	FT	265
HDPE Pipeline w/asphalt resurfacing (42", 5-10' deep)	FT	485
HDPE Pipeline (42", 5-10' deep)	FT	345
HDPE Pipeline w/asphalt resurfacing (48", 5-10' deep)	FT	570
HDPE Pipeline (48", 5-10' deep)	FT	430
HDPE Pipeline w/asphalt resurfacing (60", 5-10' deep)	FT	820
HDPE Pipeline (60", 5-10' deep)	FT	680
CMP Pipeline w/asphalt resurfacing (84", 5-10' deep)	FT	1145
CMP Pipeline (84", 5-10' deep)	FT	935
Extra depth pipe	FT	51
Contingencies and Multipliers (applied to construction subtotals)		
Mobilization/Demobilization	LS	10%
Traffic Control/Utility Relocation	LS	5-10%
Erosion Control	LS	2%
Construction Contingency	LS	30%
Engineering and Permitting (%)	LS	15-35%
Administration (%)	LS	10%

CIP #: 1

Manhassat Storm System Improvements

DESIGN ASSUMPTIONS

1,230 LF of 30" diameter and 750 LF of 36" diameter pipe to replace existing open channel/ditch conveyance system
Replace the existing outfall to Hedges Creek

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	400	$8,000
Clear and Grub brush including stumps	AC	8,200	0.25	$2,050
Structure Installation				
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600	9	$68,400
Connection to Existing Lateral	EA	1,200	2	$2,400
Connection to Existing Structure, standard	EA	2,000	1	$2,000
Demo Pipe	LF	71	900	$63,900
Outfall Improvements	EA	5,000	1	$5,000
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.25	$3,825
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (30", 5-10' deep)	FT	325	180	$58,500
HDPE Pipeline (30", 5-10' deep)	FT	240	1050	$252,000
HDPE Pipeline w/asphalt resurfacing (36", 5-10' deep)	FT	405	750	$303,750
Project Sub-Total				$769,825
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$76,983
Traffic Control/Utility Relocation	LS	5%		$38,491
Erosion Control	LS	2%		$15,397
Construction Cost Subtotal				$900,695
Construction Contingency	LS	30%		$270,209
Capital Expense Total				$1,170,904
Engineering and Permitting (%)	LS	25%		$292,726
Administration (%)	LS	10%		$117,090
			TOTAL	$1,580,720

CIP #: 2A

Nyberg Creek Stormwater Improvements - Phase I

DESIGN ASSUMPTIONS

Disconnect storm system at Mohawk Dr.

Install new storm trunkline down Martinazzi to new outfall at Nyberg Creek

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	40	$800
Energy dissipation pad - Rip-Rap, Class 100	CY	81	15	$1,215
Structure Installation				
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600	9	$68,400
Catch Basin, all types	EA	2,000	8	$16,000
Demo Pipe	LF	71	900	$63,900
Remove Manhole Structure	EA	1,000	6	$6,000
Outfall Improvements	EA	10,000	1	$10,000
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.1	$1,530
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.1	$2,030
Concrete Curbs	FT	40	1000	$40,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' deep)	FT	91	440	$40,040
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	275	1500	$412,500
Project Sub-Total				$662,415
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$66,242
Traffic Control/Utility Relocation	LS	10%		$66,242
Erosion Control	LS	2%		$13,248
Construction Cost Subtotal				$808,146
Construction Contingency	LS	30%		$242,444
Capital Expense Total				$1,050,590
Engineering and Permitting (%)	LS	35%		$367,707
Administration (%)	LS	10%		$105,059
			TOTAL	$1,523,356

CIP #: 2B

Nyberg Creek Stormwater Improvements - Phase 2

DESIGN ASSUMPTIONS

Upsize storm pipe along Warm Springs Drive

Install new outfall to Nyberg Creek at Tonka and Warm Springs

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	50	$1,000
Energy dissipation pad - Rip-Rap, Class 100	CY	66	15	$990
Structure Installation				
Precast Concrete Manhole (72", 0-8' deep)	EA	9,700	4	$38,800
Connection to Existing Lateral	EA	1,200	5	$6,000
Demo Pipe	LF	71	250	$17,750
Remove Manhole Structure	EA	1,000	2	$2,000
Outfall Improvements	EA	10,000	1	$10,000
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.5	$7,650
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.1	$2,030
Concrete Curbs	FT	40	50	$2,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (48", 5-10' deep)	FT	570	800	$456,000
Project Sub-Total				$544,220
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$54,422
Traffic Control/Utility Relocation	LS	10%		$54,422
Erosion Control	LS	2%		$10,884
Construction Cost Subtotal				$663,948
Construction Contingency	LS	30%		$199,185
Capital Expense Total				$863,133
Engineering and Permitting (%)	LS	35%		$302,097
Administration (%)	LS	10%		$86,313
			TOTAL	$1,251,543

CIP #: 2C

Nyberg Creek Stormwater Improvements - Phase 3

DESIGN ASSUMPTIONS

Upsize storm pipe along Boones Ferry Road

Install new StormFilter systems for increased treatment to Nasoma Ln.

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	30	$600
Water Quality Facility Installation				
StormFilter (2-cartridge catch basin unit, 18" cartridges)	EA	10,100	2	$20,200
Structure Installation				
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600	6	$45,600
Catch Basin, all types	EA	2,000	2	$4,000
Connection to Existing Lateral	EA	1,200	5	$6,000
Remove existing pavement	SY	10	100	$1,000
Demo Pipe	LF	71	450	$31,950
Remove Manhole Structure	EA	1,000	7	$7,000
Outfall Improvements	EA	5,000	2	$10,000
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.1	$1,530
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.1	$2,030
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' deep)	FT	91	150	$13,650
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	275	60	$16,500
HDPE Pipeline w/asphalt resurfacing (36", 5-10' deep)	FT	405	250	$101,250
HDPE Pipeline w/asphalt resurfacing (42", 5-10' deep)	FT	485	75	$36,375
Project Sub-Total				$297,685
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$29,769
Traffic Control/Utility Relocation	LS	10%		$29,769
Erosion Control	LS	2%		$5,954
Construction Cost Subtotal				$363,176
Construction Contingency	LS	30%		$108,953
Capital Expense Total				$472,128
Engineering and Permitting (%)	LS	25%		$118,032
Administration (%)	LS	10%		$47,213
			TOTAL	$637,373

CIP #: 3

Sandalwood Water Quality Retrofit

DESIGN ASSUMPTIONS

220 LF bioswale with temporary irrigation

Relocated ditch inlet structure

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	250	$5,000
Embankment	CY	9	70	$630
Amended Soils and Mulch	CY	45	165	$7,425
Energy dissipation pad - Rip-Rap, Class 50	CY	66	20	$1,320
Drain Rock	CY	101	85	$8,585
Structure Installation				
Field Ditch Inlet	EA	4,000	1	$4,000
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600	1	$7,600
Connection to Existing Structure, standard	EA	2,000	1	$2,000
Check dams	EA	505	3	$1,515
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.4	$6,120
Riparian/Wetland Planting (w/temporary irrigation)	AC	32,500	0.1	$3,250
Pipe Unit Cost				
HDPE Pipeline (30", 5-10' deep)	FT	240	20	$4,800
Project Sub-Total				$52,245
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$5,225
Traffic Control/Utility Relocation	LS	5%		$2,612
Erosion Control	LS	2%		$1,045
Construction Cost Subtotal				$61,127
Construction Contingency	LS	30%		$18,338
Capital Expense Total				$79,465
Engineering and Permitting (%)	LS	25%		$19,866
Administration (%)	LS	10%		$7,946
			TOTAL	$107,277

CIP #: 4

Mohawk Apartments Stormwater Improvements

DESIGN ASSUMPTIONS

CCTV 1,000 LF of pipe with unknown alignment and condition
Install 4 72" diameter manholes for maintenance access
Replace ditch inlet and 170 LF of 36" CMP

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Inspection				
Mainline Video Inspection	FT	3.50	1000	$3,500
Earthwork				
General Earthwork/Excavation	CY	20	75	$1,500
Clear and Grub brush including stumps	AC	8,200	1	$8,200
Structure Installation				
Field Ditch Inlet	EA	4,000	1	$4,000
Precast Concrete Manhole (72", 9-12' deep)	EA	12,200	4	$48,800
Connection to Existing Structure, standard	EA	2,000	9	$18,000
Demo Pipe	LF	71	170	$12,070
Remove Manhole Structure	EA	1,000	1	$1,000
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.1	$1,530
Pipe Unit Cost				
HDPE Pipeline (36", 5-10' deep)	FT	265	170	$45,050
Project Sub-Total				$143,650
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$14,365
Traffic Control/Utility Relocation	LS	5%		$7,183
Erosion Control	LS	2%		$2,873
Construction Cost Subtotal				$168,071
Construction Contingency	LS	30%		$50,421
Capital Expense Total				$218,492
Engineering and Permitting (%)	LS	25%		$54,623
Administration (%)	LS	10%		$21,849
			TOTAL	$294,964

CIP #: 5

Herman Road Storm System

DESIGN ASSUMPTIONS

New 36" diameter trunkline to replace existing open channel/ditch conveyance system
Water quality treatment is not included and will be reflected with roadway design
Asphalt resurfacing over pipe is not included and will be reflected with roadway design

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	250	$5,000
Structure Installation				
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600	10	$76,000
Catch Basin, all types	EA	2,000	12	$24,000
Connection to Existing Structure, standard	EA	2,000	4	$8,000
Demo Pipe	LF	71	600	$42,600
Remove Manhole Structure	EA	1,000	3	$3,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' deep)	FT	91	420	$38,220
HDPE Pipeline (30", 5-10' Deep)	FT	240	110	$26,400
HDPE Pipeline (36", 5-10' deep)	FT	265	960	$254,400
Project Sub-Total				$477,620
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$47,762
Traffic Control/Utility Relocation	LS	10%		$47,762
Erosion Control	LS	2%		$9,552
Construction Cost Subtotal				$582,696
Construction Contingency	LS	30%		$174,809
Capital Expense Total				$757,505
Engineering and Permitting (%)	LS	25%		$189,376
Administration (%)	LS	10%		$75,751
			TOTAL	$1,022,632

CIP #: 6

Blake Street Culvert Replacement

DESIGN ASSUMPTIONS

84" diameter culvert replacement
Construction to occur in conjunction with roadway widening project
Asphalt resurfacing over culvert not reelected in cost estimate.

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	900	$18,000
Embankment	CY	9	60	$540
Clear and Grub brush including stumps	AC	8,200	0.1	$820
Jute Matting, Biodegradable	SY	6	60	$360
Structure Installation				
Headwall with wingwalls, 84" pipe	EA	14,000	2	$28,000
Dewatering	EA	50,000	1	$50,000
Outfall Improvements	EA	10,000	1	$10,000
Restoration/Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	1	$20,300
Pipe Unit Cost				
CMP Pipeline (84", 5-10' deep)	FT	935	120	$112,200
Project Sub-Total				$240,220
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$24,022
Traffic Control/Utility Relocation	LS	10%		$24,022
Erosion Control	LS	2%		$4,804
Construction Cost Subtotal				$293,068
Construction Contingency	LS	30%		$87,921
Capital Expense Total				$380,989
Engineering and Permitting (%)	LS	35%		$133,346
Administration (%)	LS	10%		$38,099
			TOTAL	$552,434

CIP #: 7

Boones Ferry Railroad Conveyance Improvements

DESIGN ASSUMPTIONS

Remove existing ballast/accumulated sediment and replace with rip rap.
Install new field ditch inlet and 400 LF of 42-inch pipe.

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	165	$3,300
Energy dissipation pad - Rip-Rap, Class 100	CY	81	200	$16,200
Structure Installation				
Field Ditch Inlet	EA	4,000	1	$4,000
Precast Concrete Manhole (72", 0-8' deep)	EA	9,700	1	$9,700
Demo pipe	LF	71	400	$28,400
Outfall Improvements	EA	5,000	1	$5,000
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.1	$1,530
Pipe Unit Cost				
HDPE Pipeline (42", 5-10' deep)	FT	345	480	$165,600
Project Sub-Total				$233,730
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$23,373
Traffic Control/Utility Relocation	LS	5%		$11,687
Erosion Control	LS	2%		$4,675
Construction Cost Subtotal				$273,464
Construction Contingency	LS	30%		$82,039
Capital Expense Total				$355,503
Engineering and Permitting (%)	LS	35%		$124,426
Administration (%)	LS	10%		$35,550
			TOTAL	$515,480

CIP #: 8

89th Avenue Water Quality Retrofit

DESIGN ASSUMPTIONS

Contech CDS (Model CDS 3025) hydrodynamic separator with 150 LF of piping

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	50	$1,000
Energy dissipation pad - Rip-Rap, Class 50	CY	66	25	$1,650
Water Quality Facility Installation				
Contech CDS (Model CDS3025, 72")	EA	28,800	1	$28,800
Structure Installation				
Precast Concrete Manhole (72", 0-8' deep)	EA	9,700	1	$9,700
Flow Splitter/WQ Manhole (72", all depths)	EA	12,300	1	$12,300
Demo pipe	LF	71	100	$7,100
Remove existing pavement	SY	1,000	13	$13,000
Outfall Improvements	EA	5,000	1	$5,000
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.1	$1,530
Concrete Curbs	FT	40	20	$800
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	275	50	$13,750
HDPE Pipeline (48", 5-10' deep)	FT	430	100	$43,000
Project Sub-Total				$137,630
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$13,763
Traffic Control/Utility Relocation	LS	5%		$6,882
Erosion Control	LS	2%		$2,753
Construction Cost Subtotal				$161,027
Construction Contingency	LS	30%		$48,308
Capital Expense Total				$209,335
Engineering and Permitting (%)	LS	15%		$31,400
Administration (%)	LS	10%		$20,934
			TOTAL	$261,669

CIP #: 9

125th Court Water Quality Retrofit

DESIGN ASSUMPTIONS

Contech CDS (Model CDS 3025) hydrodynamic separator with 100 LF of piping

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	50	$1,000
Water Quality Facility Installation				
Contech CDS (Model CDS3025, 72")	EA	28,800	1	$28,800
Structure Installation				
Precast Concrete Manhole (72", 0-8' deep)	EA	9,700	1	$9,700
Flow Splitter/WQ Manhole (72", all depths)	EA	12,300	1	$12,300
Connection to Existing Structure, standard	EA	2,000	3	$6,000
Demo pipe	LF	71	50	$3,550
Remove existing pavement	SY	1,000	13	$13,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	275	50	$13,750
HDPE Pipeline w/asphalt resurfacing (36", 5-10' deep)	FT	405	50	$20,250
Project Sub-Total				$108,350
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$10,835
Traffic Control/Utility Relocation	LS	5%		$5,418
Erosion Control	LS	2%		$2,167
Construction Cost Subtotal				$126,770
Construction Contingency	LS	30%		$38,031
Capital Expense Total				$164,800
Engineering and Permitting (%)	LS	15%		$24,720
Administration (%)	LS	10%		$16,480
			TOTAL	$206,000

CIP #: 10

93rd Avenue Green Street

DESIGN ASSUMPTIONS

950 sf of flow-through stormwater planter

Curb and gutter along 550' of unimproved roadway

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	100	$2,000
Water Quality Facility Installation				
Stormwater Planter	SF	40	950	$38,000
Beehive Overflow	EA	1,500	2	$3,000
Structure Installation				
Curb Inlet	EA	1,300	4	$5,200
Connection to Existing Structure, standard	EA	2,000	2	$4,000
Abandon Existing Pipe, no excavation (12")	FT	10	30	$300
Remove Manhole Structure	EA	1,000	2	$2,000
Restoration/Resurfacing				
Trench resurfacing, Permanent ACP, 6-Inch Depth	SY	71	300	$21,300
Concrete Curbs	FT	40	550	$22,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (12", 5-10' deep)	FT	140	50	$7,000
Project Sub-Total				$104,800
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$10,480
Traffic Control/Utility Relocation	LS	10%		$10,480
Erosion Control	LS	2%		$2,096
Construction Cost Subtotal				$127,856
Construction Contingency	LS	30%		$38,357
Capital Expense Total				$166,213
Engineering and Permitting (%)	LS	25%		$41,553
Administration (%)	LS	10%		$16,621
			TOTAL	$224,387

CIP #: 11

Juanita Pohl Water Quality Retrofit

DESIGN ASSUMPTIONS

1300 sf of flow through raingarden

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	180	$3,600
Water Quality Facility Installation				
Rain Garden	SF	27	1300	$35,100
Beehive Overflow	EA	1,500	2	$3,000
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	5,600	2	$11,200
Connection to Existing Structure, standard	EA	2,000	2	$4,000
Check dams	EA	505	2	$1,010
Stem wall check dams	LF	66	90	$5,940
Restoration/Resurfacing				
Trench resurfacing, Permanent ACP, 6-Inch Depth	SY	71	50	$3,550
Concrete Curbs	FT	40	100	$4,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' deep)	FT	91	50	$4,550
Project Sub-Total				$75,950
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$7,595
Traffic Control/Utility Relocation	LS	5%		$3,798
Erosion Control	LS	2%		$1,519
Construction Cost Subtotal				$88,862
Construction Contingency	LS	30%		$26,658
Capital Expense Total				$115,520
Engineering and Permitting (%)	LS	25%		$28,880
Administration (%)	LS	10%		$11,552
			TOTAL	$155,952

CIP #: 12

Community Park Water Quality Retrofit

DESIGN ASSUMPTIONS

1550 sf of raingarden/swale

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	175	$3,500
Water Quality Facility Installation				
Rain Garden	SF	27	1550	$41,850
Beehive Overflow	EA	1,500	2	$3,000
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	5,600	2	$11,200
Connection to Existing Structure, standard	EA	2,000	2	$4,000
Abandon Existing Pipe, no excavation (12")	FT	10	60	$600
Remove Manhole Structure	EA	1,000	3	$3,000
Restoration/Resurfacing				
Trench resurfacing, Permanent ACP, 6-Inch Depth	SY	71	20	$1,420
Concrete Curbs	FT	40	150	$6,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' deep)	FT	91	25	$2,275
Project Sub-Total				$76,845
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$7,685
Traffic Control/Utility Relocation	LS	5%		$3,842
Erosion Control	LS	2%		$1,537
Construction Cost Subtotal				$89,909
Construction Contingency	LS	30%		$26,973
Capital Expense Total				$116,881
Engineering and Permitting (%)	LS	25%		$29,220
Administration (%)	LS	10%		$11,688
			TOTAL	$157,790

CIP #: 13

Water Quality Facility Restoration - Venetia

DESIGN ASSUMPTIONS

Water quality swale is approx. 15' wide, 200' long, 1.5' deep, with 4' bottom width.
2' of excavation and installation of 1' of amended soils and temporary irrigated vegetation
Refurbish maintenance access road from Lee Street

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	225	$4,500
Clear and Grub brush including stumps	AC	8,200	0.3	$2,460
Amended Soils and Mulch	CY	45	100	$4,500
Energy dissipation pad - Rip-Rap, Class 50	CY	66	5	$330
Water Quality Facility Installation				
Water Quality Facility Plantings with Trees	SF	6	2580	$15,480
Gravel Access Road	SF	5	750	$3,750
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.2	$3,060
Project Sub-Total				$34,080
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$3,408
Traffic Control/Utility Relocation	LS	5%		$1,704
Erosion Control	LS	2%		$682
Construction Cost Subtotal				$39,874
Construction Contingency	LS	30%		$11,962
Capital Expense Total				$51,836
Engineering and Permitting (%)	LS	15%		$7,775
Administration (%)	LS	10%		$5,184
			TOTAL	$64,795

CIP #: 14

Water Quality Facility Restoration - Piute Court

DESIGN ASSUMPTIONS

4,000 sf facility with a 7 ft design depth
3' of excavation and installation of 1' of amended soils and temporary irrigated vegetation
Install a maintenance access road from Piute Court

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	450	$9,000
Clear and Grub brush including stumps	AC	8,200	0.2	$1,640
Amended Soils and Mulch	CY	45	150	$6,750
Energy dissipation pad - Rip-Rap, Class 50	CY	66	10	$660
Water Quality Facility Installation				
Pond Outflow Control Structure	EA	6,100	1	$6,100
Gravel Access Road	SF	5	1000	$5,000
Structure Installation				
Flow Splitter/WQ Manhole (72", all depths)	EA	12,300	1	$12,300
Connection to Existing Lateral	EA	1,200	2	$2,400
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.5	$7,650
Riparian/Wetland Planting (w/temporary irrigation)	AC	32,500	0.1	$3,250
Project Sub-Total				$54,750
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$5,475
Traffic Control/Utility Relocation	LS	5%		$2,738
Erosion Control	LS	2%		$1,095
Construction Cost Subtotal				$64,058
Construction Contingency	LS	30%		$19,217
Capital Expense Total				$83,275
Engineering and Permitting (%)	LS	15%		$12,491
Administration (%)	LS	10%		$8,327
			TOTAL	$104,093

CIP #: 15

Water Quality Facility Restoration - Sequoia Ridge

DESIGN ASSUMPTIONS

4,000 sf facility with a 5 ft design depth

3' of excavation and installation of 1' of amended soils and temporary irrigated vegetation

Install upstream water quality/flow control manhole for offline configuration

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	450	$9,000
Clear and Grub brush including stumps	AC	8,200	0.4	$3,280
Amended Soils and Mulch	CY	45	150	$6,750
Tree removal	EA	300	30	$9,000
Energy dissipation pad - Rip-Rap, Class 50	CY	66	2	$132
Water Quality Facility Installation				
Pond Outflow Control Structure	EA	6,100	1	$6,100
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.2	$3,060
Riparian/Wetland Planting (w/temporary irrigation)	AC	32,500	0.2	$6,500
Project Sub-Total				$43,822
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$4,382
Traffic Control/Utility Relocation	LS	5%		$2,191
Erosion Control	LS	2%		$876
Construction Cost Subtotal				$51,272
Construction Contingency	LS	30%		$15,382
Capital Expense Total				$66,653
Engineering and Permitting (%)	LS	15%		$9,998
Administration (%)	LS	10%		$6,665
			TOTAL	$83,317

CIP #: 16

Water Quality Facility Restoration - Sweek Drive Pond

DESIGN ASSUMPTIONS

3,000 sf facility adjacent to larger Sweek Pond

3' of excavation and installation of 1' of amended soils and temporary irrigated vegetation

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	350	$7,000
Clear and Grub brush including stumps	AC	8,200	0.2	$1,640
Amended Soils and Mulch	CY	45	110	$4,950
Tree Removal	EA	300	30	$9,000
Energy dissipation pad - Rip-Rap, Class 50	CY	66	4	$264
Water Quality Facility Installation				
Pond Outflow Control Structure	EA	6,100	1	$6,100
Structure Installation				
Flow Splitter/WQ Manhole (72", all depths)	EA	12,200	1	$12,200
Connection to Existing Lateral	EA	1,200	3	$3,600
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.2	$3,060
Riparian/Wetland Planting (w/temporary irrigation)	AC	32,500	0.2	$6,500
Project Sub-Total				$54,314
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$5,431
Traffic Control/Utility Relocation	LS	5%		$2,716
Erosion Control	LS	2%		$1,086
Construction Cost Subtotal				$63,547
Construction Contingency	LS	30%		$19,064
Capital Expense Total				$82,612
Engineering and Permitting (%)	LS	15%		$12,392
Administration (%)	LS	10%		$8,261
			TOTAL	$103,264

CIP #17

Siuslaw Water Quality Retrofit

DESIGN ASSUMPTIONS

Replace stormwater pipe from Boones Ferry Rd to Siuslaw Lane due to condition
Regrade/amend soils in existing greenway for enhanced water quality treatment
Install sedimentation manhole upstream of swale

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	560	$11,200
Amended Soils and Mulch	CY	45	420	$18,900
Energy dissipation pad - Rip-Rap, Class 100	CY	81	15	$1,215
Structure Installation				
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600	2	$15,200
Flow Splitter/WQ Manhole (72", all depths)	EA	12,300	1	$12,300
Catch Basin, all types	EA	2,000	3	$6,000
Connection to Existing Lateral	EA	1,200	1	$1,200
Connection to Existing Structure, standard	EA	2,000	1	$2,000
Abandon Existing Pipe, no excavation (27"-36")	FT	35	70	$2,450
Check dams	EA	505	5	$2,525
Outfall Improvements	EA	3,000	2	$6,000
Restoration/Resurfacing				
Riparian/Wetland Planting (w/temporary irrigation)	AC	32,500	0.2	$6,500
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (30", 5-10' deep)	FT	325	100	$32,500
HDPE Pipeline (30", 5-10' deep)	FT	240	250	$60,000
HDPE Pipeline (48", 5-10' deep)	FT	430	100	$43,000
Project Sub-Total				$220,990
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$22,099
Traffic Control/Utility Relocation	LS	5%		$11,050
Erosion Control	LS	2%		$4,420
Construction Cost Subtotal				$258,558
Construction Contingency	LS	30%		$77,567
Capital Expense Total				$336,126
Engineering and Permitting (%)	LS	25%		$84,031
Administration (%)	LS	10%		$33,613
			TOTAL	$453,770

CIP #: 18

Water Quality Facility Restoration - Waterford

DESIGN ASSUMPTIONS

2,500 sf facility, approx. 4' deep

3' of excavation and installation of 1' of amended soils and temporary irrigated vegetation

Relocation and replacement of outlet control structure with new 24" pipe

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	560	$11,200
Clear and Grub brush including stumps	AC	8,200	0.3	$2,460
Amended Soils and Mulch	CY	45	100	$4,500
Energy dissipation pad - Rip-Rap, Class 50	CY	66	12	$792
Water Quality Facility Installation				
Pond Outflow Control Structure	EA	6,100	1	$6,100
Water Quality Facility Plantings with Trees	SF	6	1200	$7,200
Structure Installation				
Flow Splitter/WQ Manhole (72", all depths)	EA	12,300	2	$24,600
Connection to Existing Lateral	EA	1,200	8	$9,600
Abandon Existing Pipe, no excavation (21"-24")	FT	25	80	$2,000
Abandon Existing Structure	EA	1,000	1	$1,000
Remove Manhole Structure	EA	1,000	2	$2,000
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	15,300	0.2	$3,060
Riparian/Wetland Planting (w/temporary irrigation)	AC	32,500	0.2	$6,500
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	275	50	$13,750
Project Sub-Total				$94,762
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$9,476
Traffic Control/Utility Relocation	LS	5%		$4,738
Erosion Control	LS	2%		$1,895
Construction Cost Subtotal				$110,872
Construction Contingency	LS	30%		$33,261
Capital Expense Total				$144,133
Engineering and Permitting (%)	LS	15%		$21,620
Administration (%)	LS	10%		$14,413
			TOTAL	$180,166

CIP #: 19

Saum Creek Hillslope Repair

DESIGN ASSUMPTIONS

Replace existing 18-inch pipe to outfall
Install bank reinforcement to prevent further erosion
Conduct geotechnical evaluation of bank slope conditions

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
Clear and Grub brush including stumps	AC	8,200	0.1	$820
Geotextile	SY	3	140	$420
Energy dissipation pad - Rip-Rap, Class 200	CY	96	60	$5,760
Structure Installation				
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600	1	$7,600
Catch Basin, all types	EA	2,000	1	$2,000
Demo pipe	LF	71	100	$7,100
Outfall Improvements	EA	10,000	1	$10,000
Restoration/Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.4	$8,120
Pipe Unit Cost				
Underdrain, 6" perforated HDPE	LF	56	50	$2,800
HDPE Pipeline w/asphalt resurfacing (18", 5-10' deep)	FT	200	120	$24,000
Project Sub-Total				$68,620
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$6,862
Traffic Control/Utility Relocation	LS	5%		$3,431
Erosion Control	LS	2%		$1,372
Construction Cost Subtotal				$80,285
Construction Contingency	LS	30%		$24,086
Capital Expense Total				$104,371
Geotechnical Evaluation	LS	20000	1	$20,000
Engineering and Permitting (%)	LS	35%		$36,530
Administration (%)	LS	10%		$10,437
			TOTAL	$171,338

CIP #: 20

Hedges Creek Stream Repair

DESIGN ASSUMPTIONS

Costs directly from the Hedges Creek (SW Ibach Road to SW 105th Avenue) Stream Assessment, CIP Opinion of Construction Costs for Identified Sites, February 2018, GreenWorks PC and OTAK, INC. Refer to report for detailed cost information.
Stream rehabilitation
Sanitary infrastructure protection
Outfall Improvements

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Location "M"				
Capital Project Implementation Cost Total				$146,874
Location "N"				
Capital Project Implementation Cost Total				$179,793
			TOTAL	$326,667

CIP #: 21

Nyberg Water Quality Retrofit

DESIGN ASSUMPTIONS

1.5 acres water quality facility with additional site improvements
3' of excavation and installation of 1.5' of amended soils and temporary irrigated vegetation
Excavated outflow channel from facility to Nyberg Creek
Installation of low flow bypass from Martinazzi and Warm Springs to proposed facility

ITEM	UNIT	Unit Cost (2018)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	20	5362	$107,244
Clear and Grub brush including stumps	AC	8,200	1.54	$12,639
Amended Soils and Mulch	CY	45	2823	$127,050
Jute Matting, Biodegradable	SY	6	1083	$6,500
Tree removal	EA	300	20	$6,000
Energy dissipation pad - Rip-Rap, Class 50	CY	66	59	$3,911
Water Quality Facility Installation				
Pond Outflow Control Structure	EA	6,100	1	$6,100
Pond Inlet Structure	EA	4,500	1	$4,500
Water Quality Facility Plantings with Trees	SF	6	43560	$261,360
Gravel Access Road	SF	5	1800	$9,000
Beehive Overflow	EA	1,500	3	$4,500
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	5,600	2	$11,200
Precast Concrete Manhole (48", 13-20' deep)	EA	10,200	1	$10,200
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600	1	$7,600
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	1	$9,700
Flow Splitter/WQ Manhole (72", all depths)	EA	12,300	2	$24,600
Catch Basin, all types	EA	2,000	3	$6,000
Connection to Existing Lateral	EA	1,200	5	$6,000
Abandon Existing Pipe, no excavation (12")	FT	10	490	$4,900
Abandon Existing Structure	EA	1,000	3	$3,000
Remove Manhole Structure	EA	1,000	2	$2,000
Outfall Improvements	EA	7,500	1	$7,500
Restoration/Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.5	$10,150
Hydroseed, large quantities	AC	2,500	0.5	$1,250
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' Deep)	FT	91	100	$9,100
HDPE Overflow from Beehive Overflows (12", 2-5' Deep)	FT	76	75	$5,700
HDPE Pipeline w/asphalt resurfacing (12", 5-10' Deep)	FT	140	485	$67,900
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	275	275	$75,625
Project Sub-Total				$811,229
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$81,123
Traffic Control/Utility Relocation	LS	5%		$40,561
Erosion Control	LS	2%		$16,225
Construction Cost Subtotal				$949,138
Construction Contingency	LS	30%		$284,742
Capital Expense Total				$1,233,880
Engineering and Permitting (%)	LS	35%		$431,858
Administration (%)	LS	10%		$123,388
Wetland Delineation	LS	15,000	1	$15,000
Wetland Mitigation	LS	232,500	1	$232,500
			TOTAL	$2,036,626

Appendix H: Staffing Analysis

Table H-1. Staffing Analysis Summary by CIP ID#

CIP ID	Project Description	Project Information	Priority Project (Y/N)	Engineering Responsibility	Maintenance Details [a]	Estimated Annual Maintenance Resource Needs (FTE) [b]	Estimated Staff Resource Needs ($ and FTE) [c]
CIP #1 Manhasset Storm System Improvements	Replace existing conveyance open channel with pipe	• Engineering and permitting costs estimated at 25% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New infrastructure will require more frequent maintenance due to anticipated sediment accumulation (annual pipe cleaning). • Project cost (total): $1,581,000.	N	Staff/consultant	• 1,980 linear feet (LF) of new pipe • Annual pipe cleaning (20'/hr)	Approximately 100 hours of annual maintenance (0.05 FTE)	Construction administration (total): $117,000 (or 0.78 FTE)
CIP #2a Phase 1 Nyberg Creek Stormwater Improvements	Install upsized and new storm lines in Martinazzi Avenue and construct new outfall to Nyberg Creek	• Engineering and permitting costs estimated at 35% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New infrastructure will require more frequent maintenance due to anticipated sediment accumulation (annual pipe cleaning, outfall debris removal). • Project cost (total): $1,523,000.	Y	Staff/consultant	• 1,940 LF of new pipe, 1 new outfall • Annual pipe cleaning (20'/hr) • Outfall debris removal (4 hrs)	Approximately 100 hours of annual maintenance (0.05 FTE)	Construction administration (total): $105,000 (or 0.70 FTE)
CIP #2b Phase 2 Nyberg Creek Stormwater Improvements	Install upsized and new storm lines along Warm Springs Drive and construct new outfall to Nyberg Creek	• Engineering and permitting costs estimated at 35% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New infrastructure will require more frequent maintenance due to anticipated sediment accumulation (annual pipe cleaning, outfall debris removal). • Project cost (total): $1,208,000.	N	Staff/consultant	• 800 LF of new pipe, 1 new outfall • Annual pipe cleaning (20'/hr) • Outfall debris removal (4 hrs)	Approximately 44 hours of annual maintenance (0.03 FTE)	Construction administration (total): $86,000 (or 0.57 FTE)
CIP #2c Phase 3 Nyberg Creek Stormwater Improvements	Install upsized and new storm lines along Boones Ferry and install new WQ treatment facilities (StormFilter cbs)	• Engineering and permitting costs estimated at 25% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New infrastructure will require more frequent maintenance due to anticipated sediment accumulation (annual pipe cleaning, StormFilter cbs maintenance). • Project cost (total): $637,000.	N	Staff/consultant	• 535 LF of new pipe, 2 new StormFilters • Annual pipe cleaning (20'/hr) • StormFilter maintenance (6 hr/facility - assumed)	Approximately 40 hours of annual maintenance (0.02 FTE)	Construction administration (total): $47,000 (or 0.31 FTE)
CIP #3 Sandalwood Water Quality Retrofit	Retrofit existing open channel to WQ facility	• Engineering and permitting costs estimated at 25% of the construction cost. Assume consultant to complete. • Construction administration estimated at 10% of the construction cost. • New WQ facility will require annual inspections and maintenance to ensure plant viability and system functionality. • Project cost (total): $107,000.	N	Staff/consultant	• 220' water quality swale • Inspection four times/year (4 hrs total) • Annual swale maintenance (20'/hr)	Approximately 15 hours of annual maintenance (0.01 FTE)	Construction administration (total): $8,000 (or 0.06 FTE)
CIP #4 Mohawk Apartments Stormwater Improvements	CCTV pipe, replace pipe, install four new manholes and restore open channel	• Engineering and permitting costs estimated at 25% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • CCTV effort to be conducted by City staff. New manholes will require annual maintenance (previously unaccounted). • Project cost (total): $295,000.	N	Staff/consultant	• 1,000 LF of CCTV, 4 new manholes • CCTV (200'/hr) • Annual WQ manhole maintenance (1 hr/MH with biannual frequency)	Approximately 13 hours of annual maintenance (0.01 FTE)	Construction administration (total): $22,000 (or 0.15 FTE)
CIP #5 Herman Road Storm System	Construct new storm conveyance associated with roadway improvements	• Engineering and permitting costs estimated at 25% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New infrastructure will require more frequent maintenance due to anticipated sediment accumulation (annual pipe cleaning). • Project cost (total): $1,023,000.	Y	Staff/consultant	• 1,490 LF of new pipe, 12 new catch basins • Annual pipe cleaning (20'/hr) • Annual cb maintenance (1hr/cb)	Approximately 87 hours of annual maintenance (0.05 FTE)	Construction administration (total): $76,000 (or 0.51 FTE)
CIP #6 Blake Street Culvert Replacement	Replace culvert at Hedges Creek associated with roadway improvements	• Engineering and permitting costs estimated at 35% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • No additional maintenance requirements. • Project cost (total): $552,000.	Y	Staff/consultant	• 120 LF of new culvert • No increased maintenance obligation or frequency expected.	N/A	Construction administration (total): $38,000 (or 0.25 FTE)
CIP #7 Boones Ferry Railroad Conveyance Improvements	Replace 400 LF of undersized pipe, ditch inlet, install a WQ manhole and mitigate gravel migration downstream	• Engineering and permitting costs estimated at 35% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New and replaced infrastructure will require more frequent maintenance due to anticipated sediment accumulation (annual pipe cleaning, open channel maintenance) • Project cost (total): $515,000.	N	Staff/consultant	• 480 LF of replaced pipe, 150' open channel, 1 new manhole • Annual pipe cleaning (20'/hr) • Annual open channel cleaning (20'/hr) • Annual WQ manhole maintenance (1 hr/MH with biannual frequency)	Approximately 32 hours of annual maintenance (0.02 FTE)	Construction administration (total): $36,000 (or 0.24 FTE)

Table H-1. Staffing Analysis Summary by CIP ID#

CIP ID	Project Description	Project Information	Priority Project (Y/N)	Engineering Responsibility	Maintenance Details [a]	Estimated Annual Maintenance Resource Needs (FTE) [b]	Estimated Staff Resource Needs ($ and FTE) [c]
CIP #8 89th Ave Water Quality Retrofit	Install WQ CDS unit and associated piping	• Engineering and permitting costs estimated at 15% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New infrastructure will require more frequent maintenance due to anticipated sediment accumulation (annual pipe cleaning, CDS maintenance) • Project cost (total): $262,000.	N	Staff/consultant	• 150 LF of new pipe, new CDS WQ facility • Annual pipe cleaning (20'/hr) • CDS maintenance (6 hr/facility - assumed)	Approximately 14 hours of annual maintenance (0.01 FTE)	Construction administration (total): $21,000 (or 0.14 FTE)
CIP #9 125th Ct Water Quality Retrofit	Install WQ CDS unit and associated piping	• Engineering and permitting costs estimated at 15% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New infrastructure will require more frequent maintenance due to anticipated sediment accumulation (annual pipe cleaning, CDS maintenance) • Project cost (total): $206,000.	N	Staff/consultant	• 100 LF of new pipe, new CDS WQ facility • Annual pipe cleaning (20'/hr) • CDS maintenance (6 hr/facility - assumed)	Approximately 11 hours of annual maintenance (0.01 FTE)	Construction administration (total): $16,000 (or 0.11 FTE)
CIP #10 93rd Ave Green Street	Add WQ planters	• Engineering and permitting costs estimated at 25% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New WQ facility will require annual inspections and maintenance to ensure plant viability and system functionality. • Project cost (total): $224,000.	N	Staff/consultant	• 950 sf of WQ planters • Inspection four times/year (4 hrs total) • Annual planter maintenance (50 sf/hr)	Approximately 23 hours of annual maintenance (0.02 FTE)	Construction administration (total): $17,000 (or 0.11 FTE)
CIP #11 Juanita Pohl Water Quality Retrofit	Retrofit parking lot with WQ planters	• Engineering and permitting costs estimated at 25% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New WQ facility will require annual inspections and maintenance to ensure plant viability and system functionality. • Project cost (total): $156,000.	Y	Staff/consultant	• 1,300 sf of WQ planters • Inspection four times/year (4 hrs total) • Annual planter maintenance (50 sf/hr)	Approximately 30 hours of annual maintenance (0.02 FTE)	Construction administration (total): $12,000 (or 0.08 FTE)
CIP #12 Community Park Water Quality Retrofit	Retrofit parking lot with WQ planters	• Engineering and permitting costs estimated at 25% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New WQ facility will require annual inspections and maintenance to ensure plant viability and system functionality. • Project cost (total): $158,000.	Y	Staff/consultant	• 1,550 sf of WQ planters • Inspection four times/year (4 hrs total) • Annual planter maintenance (50 sf/hr)	Approximately 35 hours of annual maintenance (0.02 FTE)	Construction administration (total): $12,000 (or 0.08 FTE)
CIP #13 Water Quality Facility Maintenance - Venetia	Maintain existing WQ facility to restore function	• Engineering and permitting costs estimated at 15% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • Ongoing facility maintenance reflected in programmatic project. • Project cost (total): $65,000.	Y	Staff/consultant	• WQ facility maintenance • Project to be performed by hired contractor • Increased maintenance obligation or frequency to be accounted for in programmatic project	N/A	Construction administration (total): $5,000 (or 0.03 FTE)
CIP #14 Water Quality Facility Maintenance – Piute Ct	Maintain existing WQ facility to restore function	• Engineering and permitting costs estimated at 15% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • Ongoing WQ facility maintenance reflected in programmatic project. • Project cost (total): $104,000.	Y	Staff/consultant	• WQ facility maintenance • Project to be performed by hired contractor • Increased maintenance obligation or frequency to be accounted for in programmatic project	N/A	Construction administration (total): $8,000 (or 0.05 FTE)
CIP #15 Water Quality Facility Maintenance - Sequoia Ridge	Maintain existing WQ facility to restore function	• Engineering and permitting costs estimated at 15% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • Ongoing WQ facility maintenance reflected in programmatic project. • Project cost (total): $83,000.	Y	Staff/consultant	• WQ facility maintenance • Project to be performed by hired contractor • Increased maintenance obligation or frequency to be accounted for in programmatic project	N/A	Construction administration (total): $7,000 (or 0.05 FTE)
CIP #16 Water Quality Facility Maintenance - Sweek Pond	Maintain existing WQ facility to restore function	• Engineering and permitting costs estimated at 15% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • Ongoing WQ facility maintenance reflected in programmatic project. • Project cost (total): $103,000.	Y	Staff/consultant	• WQ facility maintenance • Project to be performed by hired contractor • Increased maintenance obligation or frequency to be accounted for in programmatic project	N/A	Construction administration (total): $8,000 (or 0.05 FTE)

Table H-1. Staffing Analysis Summary by CIP ID#

CIP ID	Project Description	Project Information	Priority Project (Y/N)	Engineering Responsibility	Maintenance Details [a]	Estimated Annual Maintenance Resource Needs (FTE) [b]	Estimated Staff Resource Needs ($ and FTE) [c]
CIP #17 Alsea/BF Rd 99th/Siuslaw Greenway	Replace failing pipes, add pretreatment and enhance water quality along greenway path with WQ swale	• Engineering and permitting costs estimated at 25% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • New WQ facility will require annual inspections and maintenance to ensure plant viability and system functionality. • Project cost (total): $454,000.	N	Staff/consultant	• One new WQ manhole • Annual WQ manhole maintenance (1 hr/MH with biannual frequency) • 500' WQ swale • Inspection four times/year (4 hrs total) • Annual swale maintenance (20'/hr)	Approximately 30 hours of annual maintenance (0.02 FTE)	Construction administration (total): $34,000 (or 0.23 FTE)
CIP #18 Water Quality Facility Maintenance - Waterford	Maintain existing WQ facility to restore function	• Engineering and permitting costs estimated at 15% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • Ongoing WQ facility maintenance reflected in programmatic project. • Project cost (total): $180,000.	Y	Staff/consultant	• WQ facility maintenance • Project to be performed by hired contractor • Increased maintenance obligation or frequency to be accounted for in programmatic project.	N/A	Construction administration (total): $14,000 (or 0.09 FTE)
CIP #19 Saum Creek Slope Repair	Replace existing outfall and repair hillslope failure	• Engineering and permitting costs estimated at 35% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • Project cost includes additional geotechnical evaluation. • No additional maintenance requirements. • Project cost (total): $171,000.	Y	Staff/consultant	• Replace outfall and bank slope repair • No increased maintenance obligation or frequency expected.	N/A	Construction administration (total): $10,000 (or 0.07 FTE)
CIP #20 Hedges Creek Stream Repair	Bank slope stabilization, infrastructure protection, and vegetation management	• Project information and costs are included in the "Hedges Creek Stream Assessment, SW Ibach St. to SW 105th Ave.", February 2018, GreenWorks PC and OTAK, INC. • Ongoing vegetation management reflected in programmatic project. • Project cost (total): $327,000.	Y	Staff/consultant	• Increased maintenance obligation or frequency due to be accounted for in programmatic project	N/A	No related staffing cost estimate
CIP #21 Nyberg Water Quality Facility	Install regional WQ treatment facility at newly acquired City property	• Engineering and permitting costs estimated at 35% of the construction cost. Assume consultant to complete. • Construction administration (City staff) estimated at 10% of the construction cost. • Project cost includes additional estimate for fees and mitigation. • Project cost (total): $2,037,000.	Y	Staff/consultant	• WQ facility maintenance • Project to be performed by hired contractor • Increased maintenance obligation or frequency to be accounted for in programmatic project	N/A	Construction administration (total): $123,000 (or 0.82 FTE)
					Capital Project Total Staffing Estimate (FTE)	**5.5 (total) or 0.6 (annual)[d]**	
					Priority Capital Project Staffing Estimate (FTE)	**2.8 (total) or 0.3 (annual)[d]**	
					Annual Program Total (FTE), see Table 8-2	**0.4**	
					Annual TOTAL (FTE), All Projects and Programs	**1.0**	
					Annual TOTAL (FTE), Priority Projects and Programs	**0.7**	

a. Annual maintenance activities are estimated based on new assets added as part of the capital project scope.

b. Hour estimate for maintenance is based on average time/task provided by city staff and is provided for reference only. For purposes of calculating an equivalent FTE per cost estimate, an annual FTE works 2080 hrs; 0.02 FTE is 40 hrs. Costs are rounded to the 0.01 FTE.

c. Estimated combined resource needs are based directly on the construction administration cost. It reflects staff time (engineering, administration, and operations) to support design, construction and annual maintenance activities. For purposes of calculating an equivalent FTE per cost estimate, an annual FTE salary was assumed at $150,000/year. Costs are rounded to the 0.01 FTE.

d. Annualized over a 10-year planning period.

Appendix I: Clean Water Services Review Comments

Appendix I

Clean Water Services' Review Comments on the Draft Tualatin Stormwater Master Plan

Clean Water Services (CWS) reviewed the April 2019 Draft Stormwater Master Plan for the City of Tualatin. Review comments were received in September 2019 and primarily included comments related to City-identified water quality project opportunity locations (Table 3-1) and the resulting water quality retrofit projects.

Through this review process, CWS identified four additional water quality opportunity locations. Two locations (Location ID 27 and 28 as identified in Table I-1 below) are proposed as alternative locations for CIPs #8 and #9. Two locations are newly identified water quality opportunity locations.

Feedback from CWS did not result in direct changes to proposed CIPs, but these additional water quality opportunity areas can be considered with implementation of the City's new Public Water Quality Facility Retrofit Program. Table I-1 summarizes the CWS-identified water quality opportunity locations.

Figure I-1 below, was provided by CWS. The figure shows proposed water quality opportunity locations compared with City-identified water quality opportunity areas.

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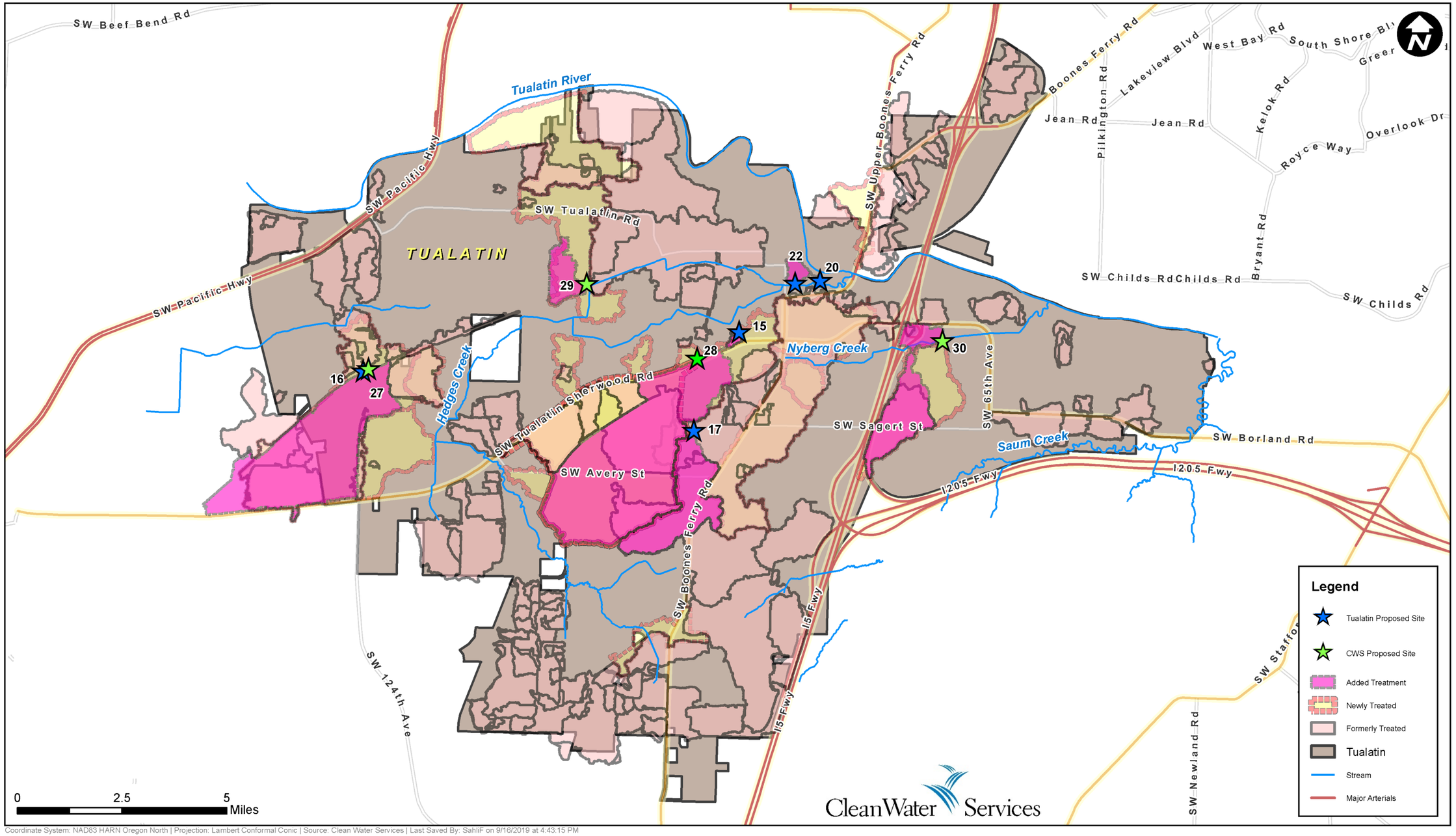
Table I-1. CWS Additional Stormwater Project Opportunities (with CWS comments)

SW Project Opportunity Area ID	Location	Basin/ Waterbody	Problem/ Project Category	Source	WQ Retrofit Opportunity	Problem/Project Area Description	Preliminary Project Concepts and Observations (per site visits)	Additional Data Collection/City Input (following Project Development Workshop)	CWS Comments
27* (alternative to Location 16)	125th to Herman Rd	Cummins Creek	Water Quality (WQ)	Stormwater CIP WQ retrofit evaluation	X	• Project identified through GIS drainage basin analysis, integrating use of archydro basin delineation and storm flow. • Large untreated area has the potential for WQ treatment (~150 acres)	• Partnership with property owners needed to provide LIDA capable of treating the flows to this location. • Installation of WQMH (sumped) will enable periodic sediment removal before natural area. • Conveyance pipe/outfall replacement due to low slope.	Flow splitter and WQMH to meet flow and sizing criteria designated by CWS standards.	Difficult location, so consider Public-Private Partnership (3P) to construct WQ facility during redevelopment.
28* (alternative to Location 15)	SW 95th Ave- SW Tualatin Sherwood Rd	Hedges Creek	WQ Infrastructure need	Stormwater CIP WQ retrofit evaluation	X	• Project identified through drainage basin analysis, integrating use of archydro basin delineation and storm flow. • Potential to treat 304 acres, of which 147 acres are currently untreated. • Potential for WQ treatment areas to be identified as upstream areas redevelop. • Ideal for WQ/green facility in adjacent open area. Consider constructed wetlands.	• Current conveyance is provided through dual 24" culverts that cross SW Tualatin-Sherwood Rd and flow into 36" CSP alongside the major arterial. • The goal would be to split flows between the current conveyance (36" CSP) and a constructed facility (low flow), which would then reconnect into the 36" pipe. • The project would require coordination with Washington County, City of Tualatin, CWS, and the developer, (as well as additional upstream property owners potentially) to advance WQ treatment opportunities. • Needs further evaluation by consultant of upstream partial WQ treatment.	• Open conveyance between culverts that cross the road and the 36" pipe can be used to place the flow splitter structure, alleviating need of pipe removal. • Facility sizing would be included in scope of project.	• Land is owned by Zidell Companies who is looking to develop it for commercial use. Consider Public-Private Partnership (3P) to construct WQ facility during redevelopment. • Opportunity for partial treatment of large untreated basin with City partnership with smaller WQF construction as upstream development occurs. • WQ project(s) could be coordinated with an expansion of the ROW by Washington County . • Reference map Site 29 additional for basin detail.
29*	SW Teton Ave & SW Herman Rd Intersection	Hedges Creek	WQ	Stormwater CIP WQ retrofit evaluation	X	• Project identified through drainage basin analysis, integrating use of archydro basin delineation and storm flow. • Large untreated area has the potential for WQ treatment (~80 acres).	Needs further evaluation by consultant of upstream partial WQ treatment .	Flow splitter and WQMH to meet flow and sizing criteria designated by CWS standards.	Opportunity for partial treatment of large untreated basin with City partnership with smaller WQF construction as upstream development occurs.
30*	SW Nyberg St/65th Ave	Nyberg St	WQ	Stormwater CIP WQ retrofit evaluation	X	• Project identified through drainage basin analysis, integrating use of archydro basin delineation and storm flow. • Large untreated area has the potential for WQ treatment (xx acres). • Expanded constructed wetland complex to provide WQ treatment before discharging into wetlands surrounding Nyberg Creek, south of SW Nyberg St.	• Potential for WQ facility near convergence of multiple open conveyance ditches, behind site with large businesses. • Expected high level of solids removal and additional treatment area. • Needs further evaluation by consultant of upstream partial WQ treatment.	Facility sizing would be included in scope of project.	• Land owned by the Nyberg Creek Foundation. • Opportunity for partial treatment of large untreated basin with City partnership with smaller WQF construction as upstream development occurs.

**Indicates that the SW Project Opportunity Area ID created by CWS as an arbitrary value to continue using the City of Tualatin format.*



Coordinate System: NAD83 HARN Oregon North | Projection: Lambert Conformal Conic | Source: Clean Water Services | Last Saved By: SahliF on 9/16/2019 at 4:43:15 PM

Figure I-1. Proposed Storm Projects for the Tualatin SMP

Source: Clean Water Services