TUALATIN CITY PLANNING COMMISSION MEETING

THURSDAY, JANUARY 21, 2021

City of Tualatin

Join Zoom Meeting
https://us02web.zoom.us/j/83673581282?pwd=K3MyM3AzL1NIdmRIL2xJYWtJV2tQdz09

Meeting ID: 836 7358 1282
Passcode: 542101

Bill Beers, Chair
Mona St. Clair, Vice Chair
Daniel Bachhuber Mitch Greene
Alan Aplin Janelle Thompson
Ursula Kuhn

CALL TO ORDER & ROLL CALL

ANNOUNCEMENTS & PLANNING COMMISSION COMMUNICATION

1. Commissioner Bachhuber would like to share the following web links that may be of interest to the Commission and public:

   https://cityobservatory.org/city-observatory-on-housing-supply-and-affordability/

   https://www.strongtowns.org/journal/2021/1/3/announcing-the-strong-towns-local-motive-tour

APPROVAL OF MINUTES

ACTION ITEMS

1. The Tualatin Planning Commission is asked to provide a recommendation to the City Council on adopting an updated Stormwater Master Plan for the City of Tualatin and updating Comprehensive Plan policies and relevant Development Code references to reflect the updated plan (Plan Text Amendment PTA 21-0001).

COMMUNICATION FROM CITY STAFF

1. A presentation on the City of Tualatin’s urban renewal efforts.

FUTURE ACTION ITEMS

ADJOURNMENT

City Observatory on housing supply and affordability

By Joe Cortright | 23.12.2020

(https://twitter.com/home?status=https://cityobservatory.org/ci
observatory-on-housing-supply-and-affordability/)

(https://www.facebook.com/sharer/sl
u=https://cityobservatory.org/city-ob
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(mailto:?Body=https://cityobservatory.org/city
observatory-on-housing-supply-and-affordability/)

(http://cityobservatory.org/feed)

Here's just some of what we've had to say about research on housing markets at City Observatory.

Building more housing lowers rents for everyone (https://cityobservatory.org/building-more-housing-lowers-rents-for-everyone/)

December 14, 2020

A new study from Germany shows that added housing supply lowers rents across the board. A 1 percent increase in housing is associated with a 0.4 to 0.7 percent decrease in rents

Want more housing? Build a landlord. (https://cityobservatory.org/want-more-housing-build-a-landlord/)
By Ethan Seltzer November 19, 2019
If we're going to have a lot more missing middle housing; we're also going to have a lot more landlords. Accessory dwellings, duplexes, triplexes and four-plexes are suited to "mom-and-pop" landlords, but tough tenants rights requirements may discourage many homeowners from creating more housing.

Triumph of the NIMBY's: Less affordable, more displacement (https://cityobservatory.org/nimby_triumph_/)
June 25, 2020
When NIMBYs win, everybody loses. Constricting housing supply drives up the price of housing further, and accelerates displacement, in rich neighborhoods and in poor ones.

Gentrification: the case of the missing counter-factual (https://cityobservatory.org/gentrification-the-case-of-the-missing-counter-factual/)
February 24, 2020
The implicit assumption in most gentrification research is that if a neighborhood doesn't change, that it stays the same, but almost no one looks at that question. Displacement by decline is much more common, and more harmful than displacement due to gentrification.

How gentrification benefits long-time residents of low income neighborhoods (https://cityobservatory.org/how-gentrification-benefits-long-time-residents-of-low-income-neighborhoods/)
July 19, 2019
The new Philadelphia Fed study of gentrification is the best evidence yet that gentrification creates opportunity and promotes integration

Anatomy of a rental marketplace (https://cityobservatory.org/anatomy-of-a-rental-marketplace/)
April 3, 2020

A new report from the DC Policy Center shows the inner-workings of the shadow rental market that is a key to housing affordability

[Why Atlanta's anti-gentrification moratorium will backfire (https://cityobservatory.org/why-atlantas-anti-gentrification-moratorium-will-backfire/)](https://cityobservatory.org/why-atlantas-anti-gentrification-moratorium-will-backfire/)
February 24, 2020
Blocking new development will only accelerate demand for existing homes. The moratorium makes flipping houses even more lucrative

[Why TOPA isn't the tops (https://cityobservatory.org/topa_not_the_tops/)](https://cityobservatory.org/topa_not_the_tops/)
January 9, 2020
Turning renters into owners is not a simple solution to housing affordability

[A solution for displacement: TIF for affordable housing (https://cityobservatory.org/a-solution-for-displacement-tif-for-affordable-housing/)](https://cityobservatory.org/a-solution-for-displacement-tif-for-affordable-housing/)
June 11, 2019
The case for using tax increment financing for affordable housing in gentrifying neighborhoods

[Another housing myth debunked: Neighborhood price effects of new apartments (https://cityobservatory.org/another-housing-myth-debunked-neighborhood-price-effects-of-new-apartments/)](https://cityobservatory.org/another-housing-myth-debunked-neighborhood-price-effects-of-new-apartments/)
June 4, 2019.
New research shows new apartments drive down rents in their immediate neighborhood, disproving the myth of "induced demand" for housing

[Kevin Bacon & musical chairs: How market rate housing increases affordability (https://cityobservatory.org/bacon_musical_chairs/)](https://cityobservatory.org/bacon_musical_chairs/)
April 15, 2019
Building more market rate housing sets off a chain reaction supply increase that reaches low income neighborhoods. Households moving into new

market rate units move out of other, lower cost housing, making it available to other households; the propagation of this effect produces additional housing supply in lower income neighborhoods

The end of the housing supply debate (maybe) (https://cityobservatory.org/the-end-of-the-housing-supply-debate-maybe/)
November 8, 2017
Slowly, the rhetorical battle is being won, as affordable housing advocates acknowledge more supply matters

Will upzoning ease housing affordability problems? (https://cityobservatory.org/will-upzoning-ease_affordability/)
May 15, 2019.
More housing supply denialism–debunked

You're going to need a bigger boat (https://cityobservatory.org/youre-going-to-need-a-bigger-boat/)
January 7, 2019
We're going to need more apartments, too. Eliminating exclusively single-family zones won't provide enough density: Recognizing the limits of "missing middle" as a solution to urban affordability

The long tail of the housing bust (https://cityobservatory.org/the-long-tail-of-the-housing-bust/)
November 19, 2018
Adjusted for inflation, US home prices are still lower than in 2006. 124 million people live in the 32 metropolitan areas where real housing prices are still below 2006 levels; just 50 million live in the 21 metropolitan areas where real housing prices are now higher than in 2006.

Homeownership: A failed wealth-creation strategy (https://cityobservatory.org/homeownership-a-failed-wealth-creation-strategy/)
July 18, 2016

Swings in credit availability work to systematically disadvantage lower income and lower wealth buyers, who tend disproportionately to be people of color.

If you want less displacement, build more housing (https://cityobservatory.org/if-you-want-less-displacement-build-more-housing/)
August 27, 2018
The more you limit housing, the more you increase displacement

We disagree with the Washington Post about housing economics (https://cityobservatory.org/wapo_rents_analysis/)
August 13, 2018
Contrary to what you think you may have read in last week's Washington Post, rental housing markets at all levels still conform to the laws of supply and demand

No exit from housing hell (https://cityobservatory.org/no-exit-from-housing-hell/)
May 3,2018
Distrust and empowering everyone to equally be a NIMBY is a recipe for perpetual housing problems.Two market rate houses reduce displacement as much as one affordable house

Is Fruitvale gentrifying? Did it prevent displacement? (https://cityobservatory.org/is-fruitvale-gentrifying-did-it-prevent-displacement/)
May 8, 2018
What does Fruitvale tell us about gentrification and displacement? Gentrification solved, or at least prevented.

Signs of the times (https://cityobservatory.org/signs-of-the-times/)
October 26, 2017
“For Rent” signs are popping up all over Portland, signaling an easing of the housing crunch and foretelling falling rent

Caught in the prisoner's dilemma of local-only planning (https://cityobservatory.org/caught-in-the-prisoners-dilemma-of-local-only-planning-2/)
September 21, 2016
Fragmented local government and the devolution of land use controls creates perverse incentives that restrict housing supply, perpetuate segregation, make housing less affordable and lead to more sprawl and pollution

When supply catches up to demand, rents go down (https://cityobservatory.org/when-supply-catches-up-to-demand-rents-go-down/)
March 21, 2016
A parable from the oil belt about housing markets.

Urban myth busting: New rental housing and median-income households (https://cityobservatory.org/urban-myth-busting-new-rental-housing-and-median-income-households/)
February 17, 2016
This myth is busted: building more high end housing doesn't make housing less affordable.

What filtering can and can't do (https://cityobservatory.org/what-filtering-can-and-cant-do/),
By Daniel Hertz
November 10, 2015
How filtering works–and doesn't work–in housing markets.

The immaculate conception theory of your neighborhood's origins (https://cityobservatory.org/the-immaculate-conception-theory-of-your-neighborhoods-origins/)
September 24, 2015
Those affordable bungalows you prize today were once yesterday's high end developer built housing.

Discussion
blog comments powered by Disqus (http://disqus.com)

Related Commentary

Why parking should pay its way instead of getting a free ride

Hartford Connecticut considers a pioneering move to make parking pay its way A higher parking tax works much like a "li... ➔

Joe Cortright | -14.1.2021 (https://cityobservatory.org/parking_pay_way/)

(https://cityobservatory.org/parking_pay_way/)
(https://cityobservatory.org/parking_pay_way/) (https://cityobservatory.org/elusive_inclusive_2021/)
(https://cityobservatory.org/parking_pay_way/)
(https://cityobservatory.org/parking_pay_way/)

The Urban Institute gets inclusion backwards, again

The Urban Institute has released an updated set of estimates that purport to measure which US cities are the most inclusiv... ➔

Joe Cortright | -11.1.2021 (https://cityobservatory.org/elusive_inclusive_2021/)

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The Week Observed, January 8, 2021

What City Observatory this week 1. 2021 is when we have to get real about tackling climate change. We've boiled our ana... ➔

Joe Cortright | -8.1.2021 (https://cityobservatory.org/the-week-observed-2021 jan8/)

(https://cityobservatory.org/the-week-observed-2021 jan8/)
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(https://cityobservatory.org/the-week-observed-2021 jan8/)
(https://cityobservatory.org/the-week-observed-2021 jan8/)

A regional green new deal for Portland

by Garlynn Woodsong Editor's note:City Observatory is pleased to publish this commentary by Garlynn Woodsong. Garlynn i... ➔

Garlynn Woodsong | -6.1.2021 (https://cityobservatory.org/agreennewdeal/)

(https://cityobservatory.org/agreennewdeal/)
(https://cityobservatory.org/agreennewdeal/)
(https://cityobservatory.org/agreennewdeal/) (https://cityobservatory.org/portland-carbon-tax/)
(https://cityobservatory.org/agreennewdeal/)
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Portland carbon tax should apply to all big polluters

By all means, Portland should adopt its proposed healthy climate fee, a $25 ton carbon tax But make sure it applies to … ➔

Joe Cortright | -5.1.2021 (https://cityobservatory.org/portland-carbon-tax/)

(https://cityobservatory.org/portland-carbon-tax/)
(https://cityobservatory.org/portland-carbon-tax/)
(https://cityobservatory.org/portland-carbon-tax/)

2021: Time to get serious about climate

Our new year's resolution should be to take climate action seriously. Time is running out to actually do something that… ➔

Joe Cortright | -4.1.2021 (https://cityobservatory.org/2021-time-to-get-serious-about-climate/)

(https://cityobservatory.org/2021-time-to-get-serious-about-climate/)
(https://cityobservatory.org/2021-time-to-get-serious-about-climate/) (https://cityobservatory.org/2020-the-year-
(https://cityobservatory.org/2021-time-to-get-serious-about-climate/)
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2020: The Year Observed

2020 was a trying, tumultuous and often tragic year. Here are some of the top commentaries that marked the year. Like… ➔

Joe Cortright | -30.12.2020 (https://cityobservatory.org/2020-the-year-observed/)

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observed/) (https://cityobservatory.org/week-obs-2020_dec18/)
(https://cityobservatory.org/2020-the-year-observed/)
(https://cityobservatory.org/2020-the-year-observed/)

The Week Observed, December 18, 2020

What City Observatory did this week 1. Want lower rents? Build more housing! A new study from Germany provides more e… ➔

Joe Cortright | -18.12.2020 (https://cityobservatory.org/week-obs-2020_dec18/)

What Matters to the Success of Cities

City Observatory
Portland, Oregon
(https://cityobservatory.org/week-obs-2020_dec18/)
info@cityobservatory.org (mailto:info@cityobservatory.org)

Announcing the Local-Motive Tour

Charles Marohn · January 4, 2021

Welcome to 2021, the Strong Towns Year of Action.

Most of us spent the end of 2020 in a subdued way. Absent were the large gatherings and revelry. Gone were the handshakes and hugs. Messages of peace and goodwill had to be delivered digitally. We all look forward to easier times.

There is a sense now that we are in the eye of a hurricane. I certainly feel that. With multiple coronavirus vaccines now being distributed, a period of unknown challenge is hopefully passing. Optimistically, we can see a way the public health part of this is resolved. There are many unknowns, but hope is not unwarranted.

In front of us is a challenge that is more ambiguous. How do we put things back together? How do we strengthen places that were financially frayed even before 2020? How do our local businesses, neighborhoods, and communities recover in an economy that has disadvantaged them in almost every way?

And, at the local level, how do we do it with the resources we have on hand? We can't wait for others to take action on our behalf. If we want to build a Strong Town, we are going to have to do that with the people around us using the things we have at our disposal.

At Strong Towns, we have many things planned to support a Year of Action, lots of stuff we are putting together and announcements we are going to make along the way. The first of many is the Local-Motive Tour.

Register for the Local-Motive Tour

With the Local-Motive Tour, we are

STRONG TOWNS

designed to kickstart the year. Whether you are a community leader, part of a professional staff working on city issues, or a concerned citizen that wants their place to be stronger and more prosperous, we are giving you the insight and guidance you need to take that next step.

Here are the ten courses included in the Local-Motive Tour:

- Go or no go? Doing the math on new projects.
- How to talk to a NIMBY.
- Picking your next bike lane battle.
- Community engagement that works.
- How to clear a path for small-scale developers in your town.
- 4 steps toward a more resilient local food system.
- 3 strategies for growing entrepreneurs in your city.
- Establishing a street design team.
- 5 simple ways to build a stronger neighborhood.
- You're not alone: How to find kindred spirits and jumpstart the Strong Towns conversation where you live.

You can participate in any one of these individually or get a pass for the entire tour. We have split it up this way to make it as affordable and accessible as possible, with thanks to some generous sponsors that are helping with that. Each course will provide continuing education credits, for those that need them. And if you are a Strong Towns Member, check your email for a discount code.

Register for the Local-Motive Tour

2021. Thank you for being the difference in your community. Keep doing what you can to build a Strong Town.

PREVIOUS

Matthew Yglesias: The Case for One Billion Americans (Part 1)

NEXT

Unsung Heroes

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City of Tualatin

CITY OF TUALATIN
Staff Report

TO:	Tualatin Planning Commissioners
THROUGH:	Steve Koper, AICP, Planning Manager
FROM:	Tabitha Boschetti, AICP, Assistant Planner and Hayden Ausland, Engineering Associate
DATE:	January 21, 2021

SUBJECT:
The Tualatin Planning Commission is asked to provide a recommendation to the City Council on adopting an updated Stormwater Master Plan for the City of Tualatin and updating Comprehensive Plan policies and relevant Development Code references to reflect the updated plan (Plan Text Amendment PTA 21-0001).

EXECUTIVE SUMMARY:
Current City of Tualatin code reflects the contents of the Tualatin Drainage Plan completed in 1972. While place-specific updates have been implemented, Tualatin has changed quite a bit since the 1970's and there has also been advancement in the field of stormwater management. The Stormwater Master Plan (2019) provides an overview of system improvements that reflect Tualatin's current needs and conditions, proactively addresses improvements needed to manage the impacts of future growth, and addresses a range of water quality, system maintenance, and capacity issues.

The scope of the updated plan includes updated technical analyses, a recommended capital improvement program, programmatic approaches such as pipe repair and replacement and vegetation management, and a set of policy recommendations such as approaches to channel erosion and beaver management. The Stormwater Master Plan outlines capital improvement projects that will improve management for existing development and that is critical to managing future development impacts. The scope also includes smaller projects and programs. Altogether, the efforts would serve the aims of maintaining our stormwater system to:

- Increase capacity;
- Address erosion;
- Increase water quality treatment;
- Address pollutant sources and/or improve treatment functions;
- Make it easier to maintain stormwater systems.

In addition to adopting the updated Stormwater Master Plan as a supporting technical background document to the Tualatin Comprehensive Plan, the scope of PTA 21-0001 includes:

- Updates to policies in Chapter 9 specific to stormwater management practices, reflecting updated recommendations, practices, and partnerships;
- An updated map of capital projects;
- Updated references to the Stormwater Master Plan in the Comp Plan and Development Code.

PUBLIC COMMENT RECEIVED:
A Virtual Open House and public comment period was held in December 2020. Many of the concerns relate to aspects of area-specific stormwater management and environmental resource code implementation that are more specifically addressed during development review, particularly the Environmental Review process and design and construction standards implemented by Clean Water Services, and are not within the additional scope of a Master Plan. Staff are in communication with individuals who have submitted comments are working to gather additional information.

RELEVANT CRITERIA:
- TDC 33.070;
- Metro Urban Growth Functional Plan;
- Applicable state land use goals
- Oregon Administrative Rules.

TUALATIN PLANNING COMMISSION OPTIONS:
The Planning Commission is asked to make a recommendation to City Council on the proposed Plan Text Amendment (PTA 21-0001). The TPC may:
1) Recommend approval either as proposed or with modifications;
2) Recommend denial; or
3) Recommend neither approval nor denial (i.e. a “neutral” recommendation).

FINANCIAL IMPLICATIONS:
The Stormwater Master Plan includes information on how the stormwater programs will be funded and supported financially, including utility rates and System Development Charges. These funding requirements will be the subject of further City Council discussion.

ATTACHMENTS:

Exhibit 1 – Stormwater Master Plan Summary
Exhibit 2 – Proposed Text Amendment
Exhibit 3 – Proposed Stormwater Master Plan
Exhibit 4 – Draft Findings
Exhibit 5 – Public Comments on Stormwater Master Plan 12-7-20 through 1-10-21

City of Tualatin

STORMWATER MASTER PLAN SUMMARY

An overview of the comprehensive 10 year plan

WHAT YOU NEED TO KNOW ABOUT THE STORMWATER MASTER PLAN

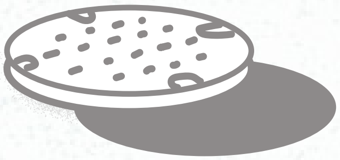
Over the past 5 years, the City of Tualatin has been working to put together a new comprehensive Stormwater Master Plan. This plan provides an overview of the system improvements needed to address:

- **City growth and development**
- **Water quality retrofits and improvements**
- **Maintenance and system condition issues**
- **Capacity issues and aging infrastructure**
- **Project, program, and policy recommendations**

100
page master plan to support us over the next 10 years of growth

21
Projects to support waterbodies in Tualatin

1900
linear feet of pipe to be installed



30
manhole covers to install, replace, or add

Project Summary

The Stormwater Master Plan includes both large capital improvement projects and smaller, routine projects intended to maintain the stormwater system. These projects are recomendations for improving our ability to proactively and effectively maintain the stormwater system to:

- **Increase capacity**
- **Address erosion**
- **Increase water quality treatment**
- **Address pollutant sources or improve treatment functions**
- **Make it easier to maintain our stormwater system**

Types of Programs In the Plan

The Master Plan also identifies programs to help the City plan out maintenance in everyday, bite sized pieces, including:

- **Infrastructure:** Repair and Replacement of Pipes + Structures
- **Maintenance:** Increase frequency of routine Public Water Quality Facility maintenance
- **New Stormwater Treatment:** Identification and construction of Public Water Quality Facilities to treat previously untreated stormwater
- **Environment:** Remove, manage, and assess invasive vegetation and physical condition of stream channels
- **Personnel:** Increase staff resources to support inspection of single family Low Impact Development Applications (LIDA)

Plan Funding

The Stormwater Master Plan includes information on how the stormwater programs will be funded and supported financially, which includes:

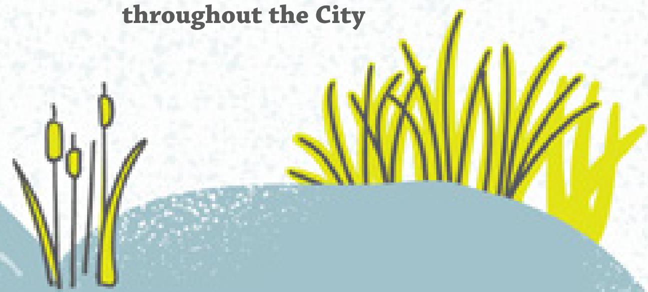
- **Utility Rates**
- **System Development Charges**

Any additional funding requirements and needs will be brought to the City Council for further discussion.

How was this plan made?

City of Tualatin worked with Brown and Caldwell consultants to research and develop this plan by:

- **Interviewing Staff**
- **Visiting stormwater facilities and project sites**
- **Modeling stormwater flows and hydrology throughout the City**



How can YOU support healthy stormwater in your neighborhood?

- **Clean up leaves around storm drains to keep the water flowing**
- **Dispose of contaminants properly**
- **Know whether you have a private water quality facility and manage properly**
- **Ask questions**

WANT TO KNOW MORE?

Read the full Stormwater Master Plan at:
bit.ly/StormwaterMP

QUESTIONS?

Email us at engineering@tualatin.gov

www.tualatinoregon.gov
@cityoftualatin

Tualatin Comprehensive Plan

[…]

B. PLAN IMPLEMENTATION

TECHNICAL MEMORANDA

Background and Supporting Documents Adopted as part of the Comprehensive Plan		
Title	**Year**	**Ordinance**
<u>Stormwater Master Plan</u>	<u>2021</u>	<u>XXXX-21</u>
Housing Needs Analysis	2019	1450-20
Parks and Recreation Master Plan	2019	1427-19
Sewer Master Plan	2019	1427-19
Water Master Plan	2013	1359-13
Transportation System Plan (TSP)	2012	1354-13
Natural Resource Inventory and Local Wetlands Inventory	1995	979-97
Historic Resource Technical Study and Inventory	1993	844-91; 894-93
~~Tualatin Drainage Plan~~	~~1979~~	~~491-79~~

Area-Specific Concept Plans		
Title	**Year**	**Ordinance**
Basalt Creek Concept Plan	2019	1418-19
Southwest Tualatin Concept Plan	2010	1321-11
Northwest Tualatin Concept Plan	2005	1191-05

[…]

CHAPTER 9 - PUBLIC FACILITIES AND SERVICES

Purpose. The purpose of this chapter is to facilitate the development of citywide public facilities in relationship to other development needs. This chapter includes water, sanitary sewer, and stormwater infrastructure goals and policies.

[…]

DRAINAGE PLAN AND SURFACE WATER MANAGEMENT

~~The Tualatin Drainage Plan is the City's drainage plan. It was originally prepared by Robert A. Wright, Consulting Engineers in 1972 and adopted in 1975 (Ord. 280-75) and in 1979 as an element of the Tualatin Community Plan (Ord. 491-79). The Tualatin Drainage Plan is referenced in the Technical Memoranda. With the supporting technical material, the Tualatin Drainage Plan provides an overall view of the drainage system, its major problems and their solutions, and is the City's stormwater and surface water drainage policy.~~

~~The Tualatin Drainage Plan was updated in the fall of 1995 by the Hedges Creek Subbasin Plan. The HCS Plan is outlined in Chapter 1 of the HCSS Report and implements the recommended drainage and stormwater management activities and facilities. The HCS Plan relies on the technical data and analysis documented in the HCSS report. The HCSS Report and the HCS Plan identify the critical importance of the Hedges Creek Marsh to drainage, stormwater management and water quality in the subbasin. The HCS Plan provides for drainage improvements, stormwater detention requirements and a number of non-structural activities for better management of water quantity and water quality in the Hedges Creek Subbasin.~~

~~Map 14-1 is from Figure I-1 of the HCS Plan. It shows the drainage pattern revisions and drainage system improvements for the Hedges Creek Subbasin. The drainage pattern revisions and drainage system improvements shown in Map 14-1 are incorporated into the Tualatin Drainage Plan.~~

~~The HCSS Report is a comprehensive technical document that provides data and analysis of stormwater drainage in the Hedges Creek Subbasin. From an analysis of several alternatives, the report recommended specific management activities and facilities to control water quantity and quality problems associated with urban stormwater runoff in the Hedges Creek Subbasin. The HCS Plan incorporates the report's recommended activities and facilities.~~

~~The Northwest Tualatin Concept Plan 2005 identifies stormwater drainage options for the area west of Cipole Road and south of Pacific Highway 99W.~~

~~The Southwest Tualatin Concept Plan 2010 identifies stormwater drainage options for the area south of SW Tualatin-Sherwood Road and east of SW 124th Avenue. Goals and Policies.~~

<u>The Stormwater Master Plan (2020) is adopted as a background document to the Comprehensive Plan as seen in Part II. Capital projects and related information is contained in the Stormwater Master Plan. The Plan supports regulatory directives under Clean Water Services (CWS)</u>

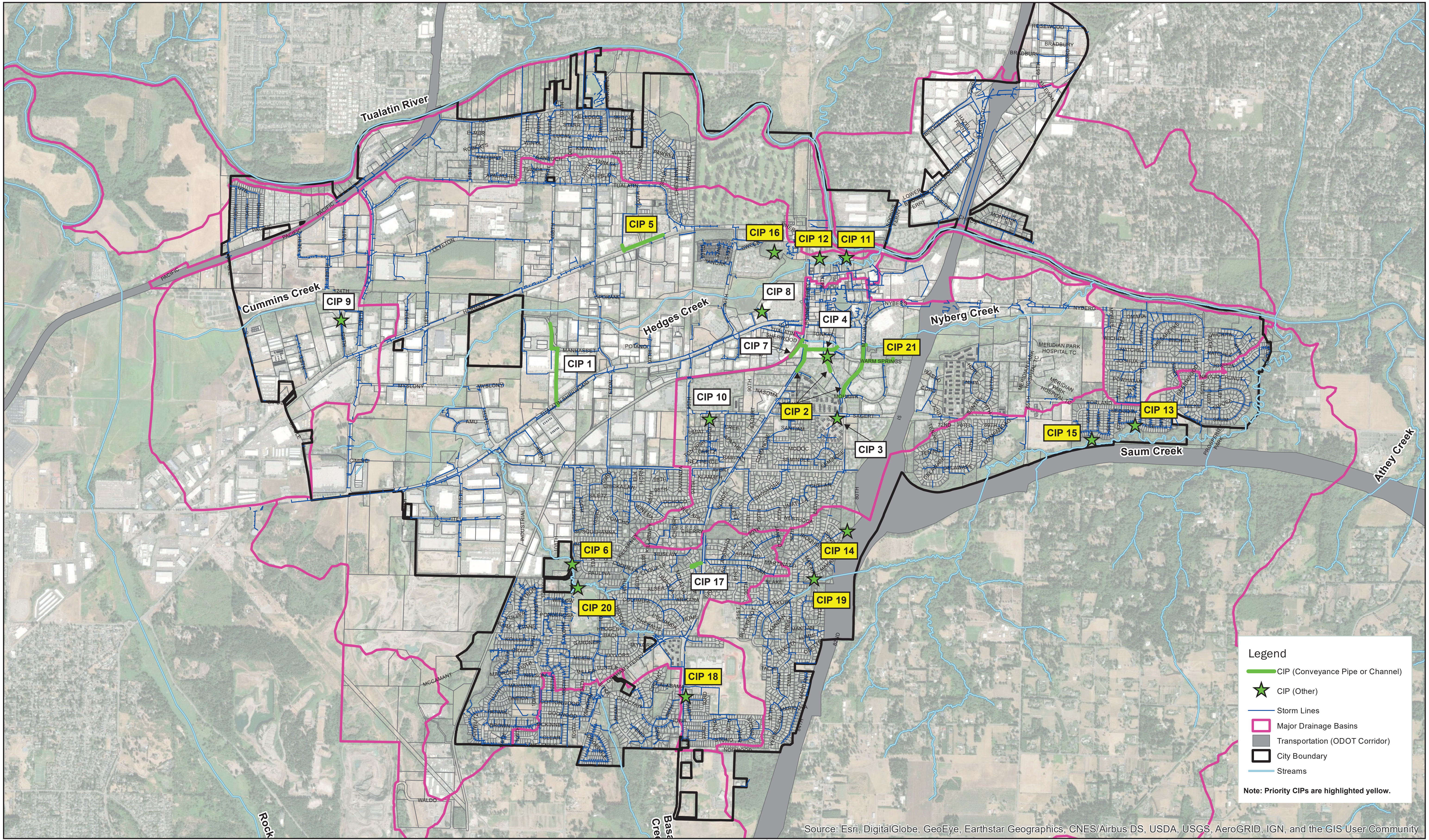
- **Goal 9.3** Provide a plan for routing surface drainage through the City, utilizing the natural drainages where possible. Update the plan as needed with drainage studies of problem areas and to respond to changes in the drainage pattern caused by urban development.
  - **Policy 9.3.1** Coordinate the City's ~~Drainage Plan and~~ Stormwater Management regulations with the City's Floodplain District, Wetland Protection District and Natural Resource Protection Overlay District regulations<u>,</u> and with the plans of ~~USA~~<u>Clean Water Services</u> and other regional, state, and federal agencies to achieve consistency among the plans.
  - <u>**Policy 9.3.2** Protect areas of the city with observed and/or reported instream erosion and hydromodification risk by requiring development to implement controls related to flow control.</u>
  - <u>**Policy 9.3.3** Increase water quality treatment throughout the City by expanding treatment area coverage through water quality retrofits and enhancing the level of treatment provided. Continue working with state and regional agencies on surface water management and water quality</u> ~~Reduce sediment and other pollutants reaching the public storm and surface water system by implementing the Oregon Department of Environmental Quality (DEQ) and USA requirements for surface water management and water quality~~ in the Tualatin River basin. Reduce soil erosion, manage surface water runoff and improve surface water quality.
  - **Policy 9.3.<u>4</u>** Identify and solve existing problems in the drainage system and plan for construction of drainage system improvements that support future development.
  - **Policy 9.3.<u>5</u>** Provide standards for surface water management and water quality by which development will be reviewed and approved. Review and update the standards as needed.
  - **Policy 9.3.<u>6</u>** Clearly indicate responsibilities for maintaining stormwater management and water quality facilities.
  - **Policy 9.3.<u>7</u>** Enforce drainage and stormwater management standards.
  - **Policy 9.3.<u>8</u>** Route stormwater runoff from the upper Hedges Creek Subbasin through the Wetland Protected Area marsh which as a wetland provides important drainage, stormwater management and water quality benefits.

- **Policy 9.3.<u>9</u>** Protect the Wetland Protected Area marsh and its important drainage, stormwater management and water quality functions in the Hedges Creek Subbasin.
- **Policy 9.3.<u>10</u>** Require new development to provide onsite pollution reduction facilities when necessary to treat stormwater runoff ~~prior to entering Hedges Creek and protect the marsh from urban stormwater pollutants~~.
- **Policy 9.3.<u>11</u>** To reduce sedimentation and erosive stormwater flow volumes, require onsite stormwater detention facilities for new development in the Hedges Creek Subbasin upstream from the Wetland Protected Area marsh.
- **Policy 9.3.<u>12</u>** Consider opportunities to construct regional pollution reduction facilities to treat stormwater runoff prior to entering Hedges Creek and protect the marsh from urban stormwater pollutants.
- **Policy 9.3.<u>13</u>** ~~Restrict beaver dam activity in the Wetland Protected Area marsh to retain the drainage flow through the marsh area and to reduce flooding between Teton Avenue and Tualatin Road.~~ <u>Implement beaver management techniques to selectively encourage/discourage beaver activity based on the characteristics of the stormwater drainage systems, topography, and vegetation.</u>
- **Policy 9.3.<u>14</u>** ~~As outlined in the HCS Plan, the City will a~~ <u>Coordinate with</u> CWS ~~with non-structural activities including~~ <u>to implement</u> public education programs and water quality and management activity monitoring.
- **Policy 9.3.<u>15</u>** Comply with Metro's Urban Growth Management Functional Plan, Title 3.
- <u>**Policy 9.3.16** Develop and support a program for continual public water quality facility maintenance, including both routine maintenance and larger system restoration and redesign as needed.</u>
- <u>**Policy 9.3.17** Validate and construct water quality retrofits, prioritizing project opportunities based on annual inspection efforts.</u>

[…]

Maps and Figures:

Adopt Capital Project Location Overview (Figure 7-1 on following page) as Map 9-3 of Comprehensive Plan



Brown AND Caldwell

City of Tualatin

City of Tualatin
Stormwater Master Plan

Date: April 2019
Project: Project 149233

N

0 2,050 4,100 Feet

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 7-1

Capital Project Location Overview

Tualatin Development Code

TDC CHAPTER 74

[…]

TDC 74.630. - Storm Drainage System.

(1) Storm drainage lines must be installed to serve each property in accordance with City standards. Storm drainage construction plans and calculations must be submitted to the City Manager for review and approval prior to construction.

(2) The storm drainage calculations must confirm that adequate capacity exists to serve the site. The discharge from the development must be analyzed in accordance with the City's Storm and Surface Water Regulations.

(3) If there are undeveloped properties adjacent to the proposed development site which can be served by the storm drainage system on the proposed development site, the applicant must extend storm drainage lines to the common boundary line with these properties. The lines must be sized to convey expected flows to include all future development from all up stream areas that will drain through the lines on the site, in accordance with the <u>adopted Stormwater Master Plan</u> ~~Tualatin Drainage Plan in TDC Chapter 14~~.

(Ord. 895-93, 5-24-1993; Ord. 933-94, § 61, 11-28-94; Ord. 952-95, § 2, 10-23-95; Ord. 1414-18, 12-10-2018)

TDC 74.640. - Grading.

(1) Development sites must be graded to minimize the impact of stormwater runoff onto adjacent properties and to allow adjacent properties to drain as they did before the new development.

(2) A development applicant must submit a grading plan showing that all lots in all portions of the development will be served by gravity drainage from the building crawl spaces; and that this development will not affect the drainage on adjacent properties. The City Manager may require the applicant to remove all excess material from the development site.

(Ord. 895-93, 5-24-1993; Ord. 1414-18, 12-10-2018)

TDC 74.650. - Water Quality, Storm Water Detention and Erosion Control.

The applicant must comply with the water quality, stormwater detention and erosion control requirements in the Surface Water Management Ordinance. If required:

(1) On subdivision and partition development applications, prior to approval of the final plat, the applicant must arrange to construct a permanent on-site water quality facility and stormwater detention facility and submit a design and calculations indicating that

the requirements of the Surface Water Management Ordinance will be satisfied and obtain a Stormwater Connection Permit from Clean Water Services; or

(2) On all other development applications, prior to issuance of any building permit, the applicant must arrange to construct a permanent on-site water quality facility and stormwater detention facility and submit a design and calculations indicating that the requirements of the Surface Water Management Ordinance will be met and obtain a Stormwater Connection Permit from Clean Water Services.

(3) For on-site private and regional non-residential public facilities, the applicant must submit a stormwater facility agreement, which will include an operation and maintenance plan provided by the City, for the water quality facility for the City's review and approval. The applicant must submit an erosion control plan prior to issuance of a Public Works Permit. No construction or disturbing of the site must occur until the erosion control plan is approved by the City and the required measures are in place and approved by the City.

(Ord. 895-93, 5-24-1993; Ord. 952-95, § 3, 10-23-95; Ord. 1070-01, 4-9-01; Ord. 1327-11 § 1; 6-27-11; Ord. 1414-18, 12-10-2018)

[…]

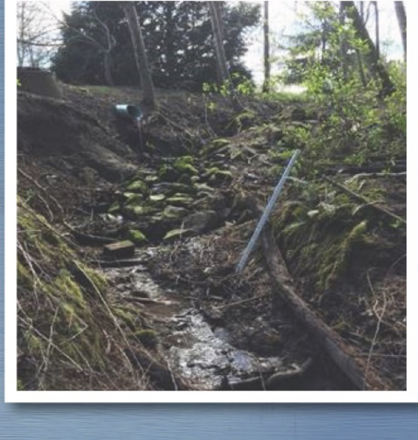
Brown AND Caldwell

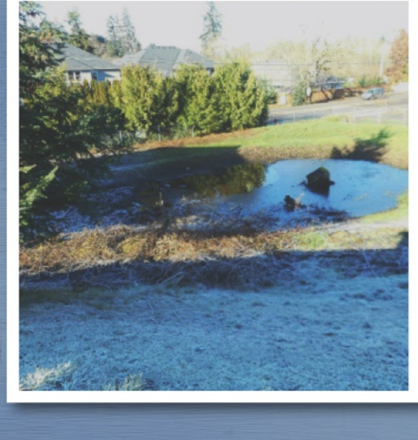
Prepared for City of Tualatin Oregon

City of Tualatin Stormwater Master Plan

City of Tualatin

April 2019 | DRAFT-FINAL





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City of Tualatin

Stormwater Master Plan

Prepared for

City of Tualatin, Oregon

April 2019

DRAFT-FINAL

Brown AND Caldwell

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

1D	one-dimensional
2D	two-dimensional
AACE	Association for the Advancement of Cost Engineering
ac	acre
BC	Brown and Caldwell
BMP	best management practice
CB	catch basin
CCTV	closed-circuit television
CIP	capital improvement projects
City	City of Tualatin
COM	commercial zoning
CWA	Clean Water Act
CWS	Clean Water Services
DEQ	Department of Environmental Quality
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorophenyltrichloroethane
District	Clean Water Services District
EPA	U.S. Environmental Protection Agency
FTE	full-time equivalent
GI	green infrastructure
GIS	geographic information system
H/H	hydrologic and hydraulic
HSG	hydrologic soil groups
I-5	Interstate 5
I-205	Interstate 205
IGA	intergovernmental agreement
IND	industrial zoning
INS	institutional zoning
LIDA	low impact development applications
LiDAR	Light Detection and Ranging
LF	linear foot/feet
LOS	level of service
mg	milligram(s)
MH	manhole(s)
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
ODFW	Oregon Department of Fish and Wildlife
O&M	operations and maintenance
OSP	open space
PCB	polychlorinated biphenyl
Permit	NPDES Permit
Plan	2019 Tualatin Stormwater Master Plan
PW	City's Public Works Standards
ROW	right-of-way
R/R	repair and replacement
SBUH	Santa Barbara Urban Hydrograph
SDC	stormwater development charge
sf	square foot/feet
SMP	2019 Tualatin Stormwater Master Plan
SWMP	Stormwater Management Plan
TDC	Tualatin Development Code
TM	technical memorandum
TMDL	total maximum daily load
VAC	vacant development
WPA	Wetlands Protection Area
WQ	water quality
XPSWMM	XP-Storm Water Management Model

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Executive Summary

In 2016, the City of Tualatin (City) initiated development of a multi-objective stormwater master plan to guide stormwater project and program priorities over a 10-year planning period. Efforts were initiated due to the outdated nature of the City's previous stormwater plan (dated 1972), the changing regulatory environment for the City, new and redevelopment activities and annexations, and observed system deficiencies warranting additional study.

This 2019 Stormwater Master Plan (Plan or SMP) provides an overview of system improvements needed to address future growth, water quality, maintenance/system condition issues, and capacity issues.

The SMP development process included:

- Identifying and investigating known capacity and maintenance-related problem areas and water quality project opportunity areas.
- Developing hydrologic and hydraulic models to evaluate system capacity for targeted problem areas or systems.
- Evaluating stream channel conditions with respect to erosion and development impacts.
- Assessing current maintenance obligations and stormwater program needs to support identified problem areas.
- Developing an integrated stormwater system capital improvement program, including project and program recommendations and costs.
- Evaluating stormwater utility rates and stormwater development charges (SDC) to implement priority project and program recommendations.
- Developing a Master Plan document that is useful and easy to read, reference, and update.

Master Plan Technical Analyses

Developing this SMP included the following technical analyses to evaluate stormwater system deficiencies and define project and program needs.

Project Needs Identification. This effort included distributing surveys and questionnaires to City staff, GIS data review, site visits and, workshops. Information collected helped with developing a robust inventory of stormwater problem areas specific to stormwater infrastructure, stormwater facilities, outfalls, and natural systems. Stormwater problem areas were reviewed to identify locations in need of further analysis or study.

Water Quality Assessment. Water quality opportunity areas were initially identified using GIS to assess vacant/public lands, high pollutant-generating land use areas (i.e., industrial or commercial), and existing stormwater facility placement. Site visits were conducted in conjunction with identified water quality opportunity areas and identified stormwater problem areas to see if an integrated approach to stormwater management (i.e., installing water quality facilities to mitigate stormwater runoff) could help address the reported issue.

Targeted Stormwater System Capacity Evaluation. Hydrologic and hydraulic (H/H) modeling to simulate rainfall and runoff characteristics was conducted for targeted areas of the city. The models simulate stormwater flow through pipe networks, drainage ditches, and culverts to identify capacity limitations for both current and future development conditions.

Targeted Stream Assessment. A stream assessment was conducted to evaluate specific stream reaches in the city reported to have erosion, invasive vegetation, and hillslope stability issues. The assessment provided baseline information regarding existing physical stream conditions and informed project, program, and policy recommendations.

Maintenance Assessment. A maintenance assessment was conducted to evaluate current City maintenance obligations and maintenance-related stormwater problem areas likely addressed with increased maintenance efforts or activities. Conveyance system deficiencies and public/private water quality facility deficiencies were highlighted and used to support project and program recommendations.

General Recommendations

Project, program and policy recommendations in this SMP are proposed to improve and enhance drainage infrastructure and water resources throughout the city, as summarized by the following general recommendations:

- Implement identified system capacity improvements (i.e., reconfiguration, rerouting, upsizing) to manage more frequent, nuisance system flooding.
- Increase water quality treatment throughout the city by expanding treatment area coverage through water quality retrofits and enhancing the level of treatment provided.
- Conduct proactive maintenance of the City's stormwater infrastructure. Use system condition data currently collected (i.e., stormwater facility inspections, closed-circuit television [CCTV]) to evaluate needs and priorities.
- Consider the topographic limitations and flat grade of the City's conveyance network with regard to system maintenance activities. Sediment removal and vegetation management are key maintenance needs to ensure conveyance capacity.
- Continue coordination with Clean Water Services to ensure updates to the Tualatin Development Code (TDC) and Public Works (PW) Standards are in line with regulatory drivers and protect stream health.
- Ensure timely implementation of capital projects and programs by establishing updated funding mechanisms and rates. Additional funding is needed to adequately manage the drainage system as material costs increase, flows increase, and the drainage system deteriorates with age and use.

Capital Improvement Program Summary

Project and program recommendations represent an integrated strategy to address stormwater needs in the city. Recommendations include 21 capital projects and six programmatic efforts. Policy recommendations stemming from the stream assessment have also been identified.

Project Summary

Capital improvement projects (CIP) have been developed to address the following objectives:

- Increases capacity (flood control)
- Address erosion
- Increase water quality treatment (retrofit)
- Improve water quality (through existing site or facility modifications/restoration to address a pollutant source issue or improve treatment function)
- Address maintenance needs

Table ES-1 below summarizes the identified capital projects, estimated costs, and priorities. Figure ES-1 shows the location of the proposed CIPs, with priority projects identified. Detailed fact sheets for each CIP can be found in Appendix A.

Table ES-1. Capital Project Summary

Priority Project	CIP Number	CIP Name	Cost estimates
	1	Manhasset Storm System Improvements	$1,581,000
X (Phase 1)[a]	2	Nyberg Creek Stormwater Improvements	$3,412,000
	3	Sandalwood Water Quality Retrofit	$107,000
	4	Mohawk Apartments Stormwater Improvements	$295,000
X	5	Herman Road Storm System	$1,023,000
X	6	Blake St Culvert Replacement	$552,000
	7	Boones Ferry Railroad Conveyance Improvements	$515,000
	8	89th Avenue Water Quality Retrofit	$262,000
	9	125th Court Water Quality Retrofit	$206,000
	10	93rd Avenue Green Street	$224,000
X	11	Juanita Pohl Water Quality Retrofit	$156,000
X	12	Community Park Water Quality Retrofit	$158,000
X	13	Water Quality Facility Restoration - Venetia	$65,000
X	14	Water Quality Facility Restoration - Piute Court	$104,000
X	15	Water Quality Facility Restoration - Sequoia Ridge	$83,000
X	16	Water Quality Facility Restoration - Sweek Drive Pond	$103,000
	17	Siuslaw Water Quality Facility Retrofit	$454,000
X	18	Water Quality Facility Restoration - Waterford	$180,000
X	19	Saum Creek Hillslope Repair	$171,000
X	20	Hedges Creek Stream Repair	$327,000
X	21	Nyberg Water Quality Retrofit	$2,037,000
		Total	$12,015,000
		Total (Priority projects only)	$6,482,000

a. CIP 2, Nyberg Creek Stormwater Improvements includes three phases of development. Phase I implementation is considered priority.

Programmatic Summary

In addition to the identified capital projects, the following stormwater program needs and/or refinements have been identified to address ongoing maintenance deficiencies and proactively address long-term system replacement and water quality improvements:

- **Pipe Repair and Replacement (R/R) Program.** Establishes an annual funding mechanism to repair and replace piped stormwater infrastructure throughout the city over a 100-year planning period. Efforts will include evaluating CCTV results to prioritize locations requiring R/R.
- **Structure R/R Program.** Establishes an annual funding mechanism to repair and replace stormwater structures throughout the city over a 100-year planning period.
- **Public Water Quality Facility Maintenance Program.** Increases existing annual funding for public stormwater facility maintenance to address both routine and restorative maintenance activities. Efforts will prioritize locations identified during annual inspection efforts.
- **Public Water Quality Facility Retrofit Program.** Establishes an annual funding mechanism to identify and construct opportunistic water quality retrofits. Retrofits may include rehabilitating existing facilities to promote enhanced treatment or installing green streets in conjunction with transportation improvement projects.
- **Stream Vegetation Management.** Establishes an annual funding mechanism to conduct instream or riparian vegetation management activities to remove invasive vegetation and assess physical condition changes to stream channels.
- **Single Family LIDA Inspection Program.** Increases staff resources to support an expanded private stormwater facility inspection program targeting low impact development applications (LIDA) on single-family residential properties.

Policy Recommendations

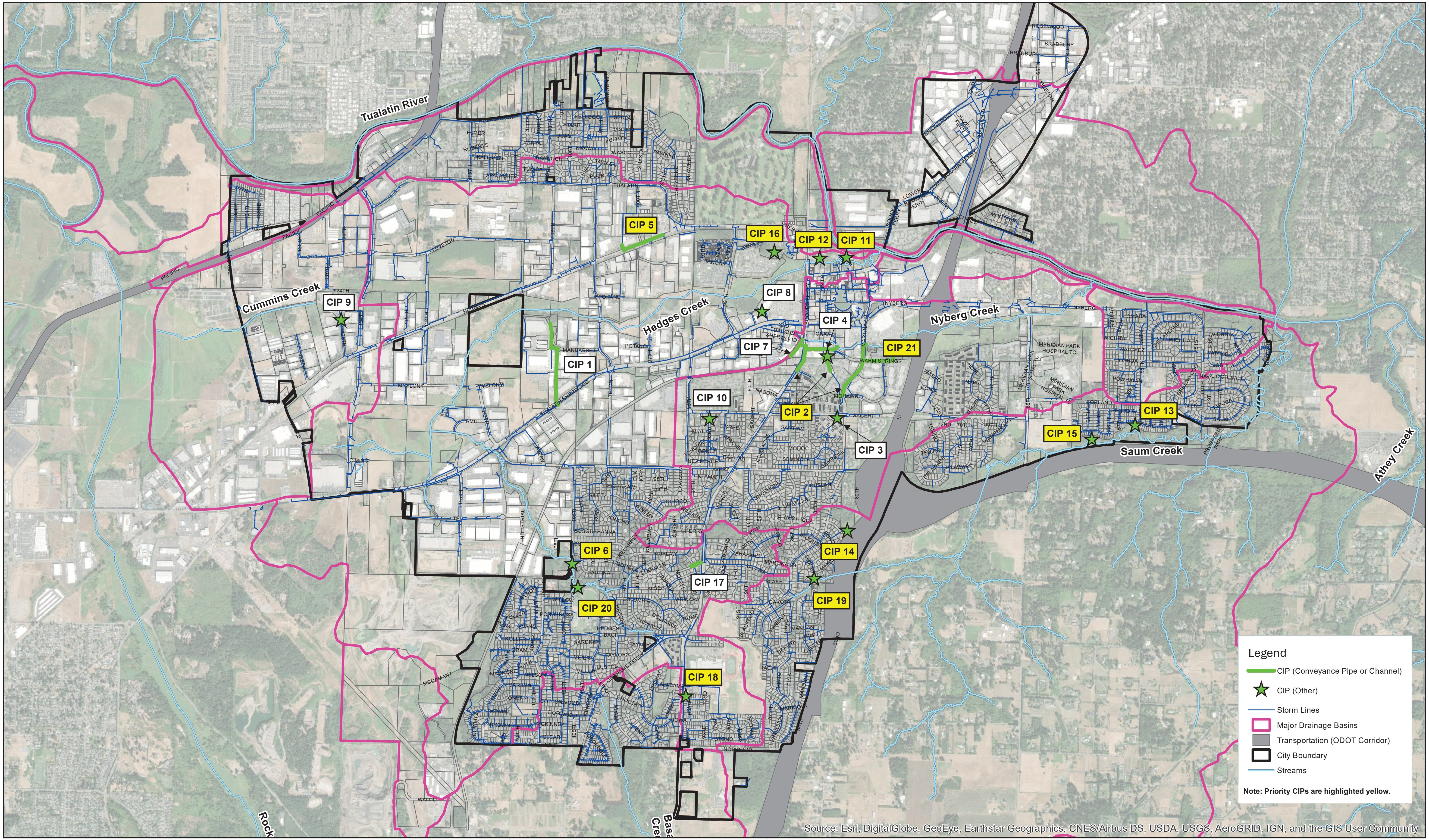
The Stream Assessment identified two policy recommendations the City may consider in order to improve instream channel health and mitigate the potential for localized flooding and erosion.

- **Flow Control Standards.** Protect select areas of the city with observed and/or reported instream erosion and hydromodification risk by requiring development to implement controls related to flow control. The City may incorporate flow control requirements in accordance with areas identified and experiencing channel erosion and incision through the adoption of Clean Water Services' (CWS) updated Design and Construction Standards, which include standards for water quantity control and hydromodification.
- **Beaver Management Guidelines.** Implement (via internal directive or codification) beaver management techniques to selectively encourage/discourage beaver activity based on the characteristics of the stormwater drainage systems, topography, and vegetation.

Implementation

Capital project and program cost information developed as part of this SMP were used to develop a financial plan for the City that outlines stormwater utility rate and SDCs necessary for the City to implement its stormwater capital improvement program while meeting other financial obligations. Capital project costs, program costs, and associated staffing needs were collectively used in the financial plan.

Implementing priority capital projects and programs associated with a 10-year planning period as outlined in this Plan will require a rate increases and adjustments to SDCs. The financial plan has not been directly included in this Plan, pending future City Council approval.



Brown AND Caldwell

City of Tualatin

City of Tualatin

Stormwater Master Plan

Date: April 2019
Project: Project 149233

N

0 2,050 4,100 Feet

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

ES-1

Capital Project Location Overview

Section 1

Introduction

The City of Tualatin (City) developed this citywide Stormwater Master Plan (SMP or Plan) to guide stormwater capital project and program decisions over a 10-year planning period. This SMP addresses both water quantity and quality for constructed systems under the City's management.

The City manages approximately 93 miles of piped and open channel stormwater infrastructure. The City has experienced rapid growth and development over the last 20 years that thus has a relatively new collection and conveyance system. However, development rates and projections indicate that the stormwater system will require expansion and upgrades to accommodate future growth. The City needs a proactive plan to address capacity needs, replace failing infrastructure, and address regulatory drivers related to water quality improvement.

This Plan documents the process and methods used to evaluate the City's drainage infrastructure and natural systems. Results of the evaluation provide the City with projects and programmatic stormwater actions for implementation. The study area for this Plan includes all areas within the city limits and three planning areas (Northwest Concept Area, Southwest Concept Area, Basalt Creek Concept Area). Major receiving water bodies include Nyberg Creek, Hedges Creek, Saum Creek and the Tualatin River mainstem.

1.1 Stormwater Master Plan Objectives

The City's overarching goal for this SMP is to guide stormwater infrastructure improvements for the natural and built environment over a 10-year implementation period. Improvements must address future growth, water quality, maintenance/system condition issues, and capacity issues. Outcomes from this effort include a prioritized project list, subsequent program recommendations, and a financial analysis that includes rate recommendations to support the implementation of projects and programs.

Specific objectives related to development of this SMP include:

- Establishing a foundation for evaluating stormwater system needs in Tualatin and soliciting information from staff and stakeholders to inform the targeted and integrated identification of project needs and improvements.
- Identifying existing problem areas and providing project solutions related to collection, conveyance, treatment and detention. This includes:
  - Developing hydrologic and hydraulic (H/H) models to evaluate system capacity limitations and assess the frequency of nuisance flooding based on current system information as obtained from the City's GIS and survey.
  - Identifying water quality treatment opportunities throughout the city to be accomplished through water quality retrofits and existing system improvements.
  - Assessing stream health and physical conditions to develop a baseline condition assessment for future evaluations and identify project and program needs.
- Developing programs to support proactive maintenance of infrastructure.

- Reviewing current stormwater program funding, including rates and system development charges, and establishing an updated funding strategy and rates to manage the drainage system and construct recommended (priority) improvements.
- Establishing baseline cost estimates (Association for the Advancement of Cost Engineering [AACE] Class 5) for recommended stormwater improvements for use in planning and budgeting.

This Plan is intended to support regulatory directives under Clean Water Services' (CWS or District's) watershed-based National Pollutant Discharge Elimination System (NPDES) permit (Permit), of which the City is a co-implementor. The City is required to meet stormwater-related obligations and programs as documented in CWS' Stormwater Management Plan (SWMP) and referenced in intergovernmental agreements (IGA). Identifying water quality improvement and stormwater retrofits is a focus of the current (2016) Permit and SWMP.

In addition, the City values its natural systems and open spaces that are available to the community. Protecting natural systems (wetlands, stream channels, riparian corridors, and vegetated buffers) is important for maintaining a livable and healthy city. This Plan was also developed to support management of these natural resources and support their beneficial uses.

1.2 Background and Related Studies

The City's last stormwater master plan was completed in 1972 and does not reflect the current condition or configuration of the City's stormwater infrastructure. The City does not have a capital project list that directly reflects current development activities, population growth, and regulatory drivers. Updated project and program strategies included in this Plan represent priority needs for future budgeting.

The city is one of the fastest growing communities in Oregon, which has prompted the need to invest in infrastructure and consider long-range planning and policy decisions to support businesses and residential life. Copies of various planning-level reports and studies prepared since the last stormwater master plan were obtained to help inform areas of high growth potential and to identify stormwater system deficiencies and needs. Reports and studies reviewed and considered for this master plan update are detailed in Table 1-1.

Table 1-1. Existing Stormwater Planning Documentation and Reports

Report	Date	Summary and Application to the SMP
Tualatin Drainage Plan Report	1972	Provides background information and historic basis for the need to update the SMP.
Hedges Creek Wetlands Master Plan	2002	Provides stormwater management recommendations (culvert upsizing under Tualatin Road, sediment removal) related to the 29-acre Hedges Creek Wetlands.
Bridgeport Area Stormwater Master Plan	2005	Provides stormwater system information and a subbasin delineation in the Bridgeport Development Area.
Southwest Tualatin Concept Plan	2010	Provides guidance for industrial development in southwest Tualatin. Planning district/zoning designation is available.
Basalt Creek Existing Conditions Report	2014	Provides surrounding land use and demographic information for the Basalt Creek Planning Area. Does not provide official planning district/zoning designation or proposed transportation corridors.
Hedges Creek Stream Assessment	2018	Independent stream assessment from SW Ibach Street to SW 105th Avenue. Results were used to supplement the stream assessment conducted as part of this SMP.
Basalt Creek Concept Plan	2018	Provides preferred land use and recommends high-level concepts for transportation and infrastructure planning for the Basalt Creek Planning Area.

1.3 Stormwater Master Plan Development Process

The approach used to develop this Plan is provided in Figure 1-1.

This process leveraged City staff knowledge and existing data (see Planning Process in Figure 1-1) to conduct focused evaluations on areas/infrastructure where additional investigation is likely to inform capital projects and programs. This approach focused resources on the areas currently identified as problems. The overall process was implemented as follows:

1. Data reconnaissance and solicitation of input from City staff and stakeholders was conducted at the beginning of the project to identify stormwater problem areas (Planning Process). Targeted locations requiring modeling or stream assessment to inform project/program needs were identified.
2. A water quality assessment was conducted to identify water quality project opportunities and supplement stormwater problem areas and preliminary project needs (Planning Process).
3. A capacity evaluation (H/H modeling) and a stream assessment were completed to further define project and program solutions (Capacity Evaluation and Stream Assessment).
4. Project Opportunity Areas were defined geographically from identified stormwater problem areas and water quality opportunity areas and vetted based on evaluations/assessments, field visits, and workshops.
5. A maintenance assessment was conducted to define current maintenance obligations and programmatic activity needs (Maintenance Assessment).
6. Capital project and program descriptions and cost estimates were developed and vetted with City staff for inclusion in the Plan (Capital Improvement Program).
7. Staffing analysis, project prioritization, and development of other cost information to support the financial evaluation (rate and system development charges) were completed.
8. Documentation of the master planning approach and project and program descriptions and costs was completed at the end of the process.

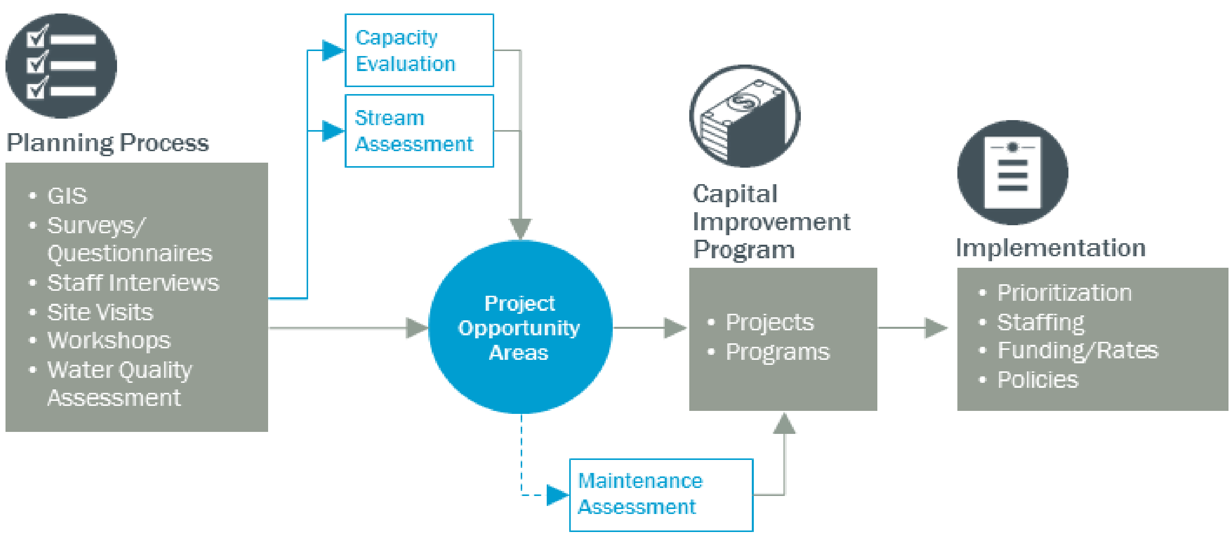


Figure 1-1. Stormwater Master Plan approach

1.4 Document Organization

Following this introductory Section 1, this SMP is organized as follows:

- Section 2 includes a description of the study area characteristics.
- Section 3 summarizes the planning process, which includes preliminary identification of problem areas, water quality opportunities, modeling needs, and stream assessment needs. Project Opportunity Areas stemming from the planning process are identified.
- Section 4 describes H/H modeling methods and results of the stormwater capacity evaluation and includes identifying capacity-related capital projects.
- Section 5 describes the stream assessment methods and results and identifies capital project, program, and policy recommendations stemming from field observations.
- Section 6 describes the maintenance assessment, including results of the Programmatic Activity Workshop. Capital project and program recommendations stemming from the maintenance assessment are identified.
- Section 7 summarizes the overall capital improvement program recommendations, including the final capital projects, programs and respective cost estimates.
- Section 8 provides an overview of the implementation elements of the capital improvement program, including a summary of staffing needs to support proposed projects and programs, the project prioritization process, level of service determination, and financial evaluation results.

Section 2

Study Area Characteristics

This section provides an overview of study area characteristics and stormwater system operations, including location, topography, soils, land use, drainage system configuration, and stormwater program activities.

Referenced figures reflecting study area characteristics are located at the end of this section.

2.1 Location

The City of Tualatin is located 13 miles southwest of Portland, Oregon. Most of the city is in Washington County, with a small portion of area along the eastern city limits located in Clackamas County (Figure 2-1). Neighboring areas include the cities of Tigard, King City and Durham to the north; the City of Wilsonville to the south; unincorporated Washington County, including the Tualatin River National Wildlife Refuge, to the west; and unincorporated Clackamas County, commonly referred to as the Stafford Triangle, to the east.

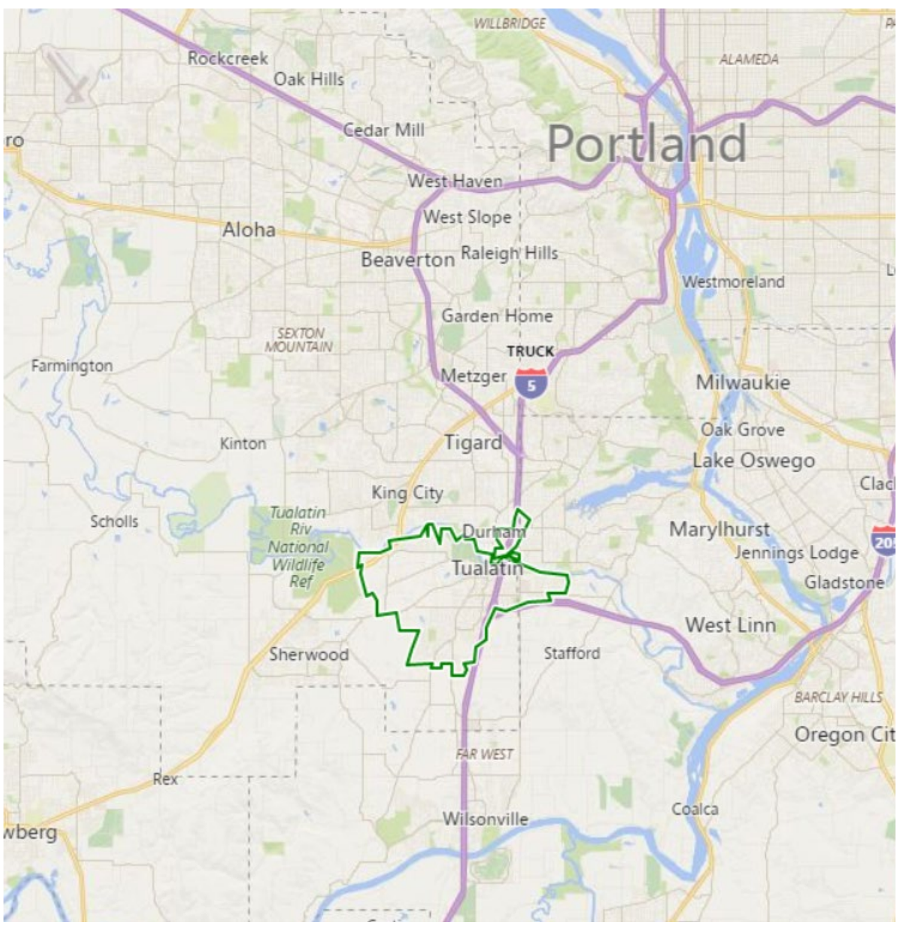


Figure 2-1. Location overview

Interstate 5 (I-5) runs north-south through the city, attributing to the large commercial corridor along the I-5 right-of-way (ROW). The intersection of I-5 and Interstate 205 (I-205) is in the southeast area of the city. Oregon Highway 99W intersects the City in the northwest corner. The city boasts a strong commercial and industrial economy, and prominent waterways access and parks, which make the city one of the most livable communities in the Portland metro area.

The city is approximately eight square miles in area, with an additional 1.2 square miles associated with planning areas outside of the city limits (Figure 2-2). The majority (approximately 97 percent) of the city discharges to the Tualatin River and tributaries. Major tributaries include Nyberg Creek, Hedges Creek, Cummins Creek, and Saum Creek. Area along the northern portion of the city discharges north directly to the Tualatin River, whereas the tributaries generally run east-west across the city before discharging into the Tualatin River. The remainder (approximately 3 percent) of the city discharges to Basalt Creek, a tributary located in the southern portion of the City, which runs south to Coffee Lake Creek in the City of Wilsonville before discharging to the Middle Willamette River.

2.2 Future Planning Areas

There are three future planning areas in the city: The Southwest Concept Plan Area, the Northwest Concept Plan Area and the Basalt Creek Planning Area (Figure 2-2).

Concept plans for these areas have been developed to guide future development and expansion as the City grows. These areas have yet to undergo significant development or redevelopment. Concept plans help facilitate communication with citizens and stakeholders by laying out how the area might be developed with respect to land use, transportation, natural resources and utility planning. Concept plans also aid in determining future financial implications and the level of potential investment required to develop and provide infrastructure throughout the planning area.

Detail related to these three future planning areas are as follows:

- **Southwest Concept Plan Area***:* The Southwest (SW) Concept Plan was completed in August 2005 to guide industrial development of a 614-acre area located south of Tualatin-Sherwood Road between SW 115th and 124th avenues. The area is near the Tigard Sand and Gravel Quarry. In 2011, the SW Concept Plan was updated and adopted into the Tualatin Development Code (TDC). The portion of the planning area within the urban growth boundary and north of Tonquin Road (approximately 431 acres) was included in this SMP.
- **Northwest Concept Plan Area:** The Northwest (NW) Tualatin Concept Plan was completed in March 2005 and incorporated into the City's Development Code in June 2005. The NW concept planning area is 14 acres, located in the northwest corner of the city, and mostly developed. This planning area was included in this SMP.
- **Basalt Creek Planning Area:** The Basalt Creek Concept Plan was adopted by City Council in August 2018. The Plan was developed as a joint effort between the cities of Tualatin and Wilsonville. The area is located between the southern boundary of the Tualatin and northern boundary of Wilsonville. The total planning area encompasses 847 acres. Tualatin's portion of the planning area (approximately 356 acres) was included in this SMP.

2.3 Topography

Tualatin's topography is characterized as relatively flat with gentle slopes (Figure 2-3). The elevation in the city varies from 368 feet at the highest point to 96 feet at the lowest point. The lowest elevation areas are along the northern border of the city at the Tualatin River. The highest elevation areas are near SW Boones Ferry Road and SW Norwood Road.

The flat topography results in limited slope in the stormwater collection system, which contributes to standing water in pipes, backwater conditions, and high sediment accumulation. The average slope in the stormwater collection system ranges from 0.5 percent to 6.5 percent. There are significant wetland areas within the city, particularly along Hedges Creek and the downstream portion of Nyberg Creek, further attributed to the flat topography, high groundwater levels, and proximity to the Tualatin River.

More significant grade changes are observed in the southeast portion of the city, north of Saum Creek, where a steep ridge defines the northern stream bank and the southwest part of the city, adjacent to the SW Concept Plan Area.

2.4 Soils

The National Resources Conservation Service (NRCS) Soil Survey online tool was used to gather soils information for Tualatin. Soils are an important watershed characteristic for evaluating potential runoff rates and volumes. Soils are generalized into four categories or hydrologic soil groups (HSG), which approximate soil runoff potential. These groups are A, B, C, and D, where A soils are characterized by high rates of infiltration and low runoff potential and D soils are characterized by low rates of infiltration and high potential for runoff. HSG conditions are reflected on Figure 2-3.

Most of the soils in Tualatin are HSG Type C soils with pockets of A, B, C/D and D type soils. Table 2-1 shows the NRCS hydrologic soils group by percent coverage within the city limits and planning areas.

Table 2-1. Soil Type within the City and Planning Areas

Hydrologic Soil Group	Acres	Percent
A	181	3
B	708	12
C	3,820	63
C/D	876	15
D	423	7
Total	6,008	100

There are saturated soils and wetland soil conditions along stream reaches and throughout the city. The City maintains a Wetlands Protection Area (WPA) GIS inventory that includes riparian areas along Hedges Creek, Nyberg Creek, and Saum Creek.

2.5 Land Use

Tualatin is a community that has experienced significant growth over the last 20 years. The population of Tualatin is approximately 27,500 as of July 1, 2017. The population has increased 5.2 percent between 2010 and 2017.

The city is primarily composed of industrial and residential land use, with significant areas of commercial development along the I-5 corridor and Tualatin-Sherwood Road. Large tracts of open space area (parks, greenways, natural areas, wetlands) are scattered throughout the city. Vacant lands with potential for development are located primarily in the western portion of the city.

Land use coverage was developed in GIS as part of this SMP to evaluate stormwater drainage conditions in the city. Land use coverage was based on City-provided GIS coverage of planning districts (zoning), open space areas, and developable lands. A detailed summary of the process to develop the City's land use coverage and associated impervious area estimates is provided in Technical Memorandum 1 (TM1), included in this SMP in Appendix B. Land use coverage is shown on Figure 2-4. Land use categories and impervious assumptions are reflected in Table 2-2.

Table 2-2. Land Use Categories and Impervious Percentages

Planning District Designation	Modeled Land Use Category	Impervious % (Existing)	Impervious % (Future)
Low-Density Residential	Low-density residential	43	53
Medium Low-Density Residential Medium High-Density Residential	Medium-density residential (MDR)	45	55
High-Density Residential High-Density High Rise Residential	High-density residential	50	60
General Commercial Central Commercial Medical Commercial Office Commercial Recreational Commercial	Commercial (COM)	78	78
General Manufacturing Light Manufacturing Manufacturing Business Park Manufacturing Park	Industrial (IND)	74	74
Institutional	Institutional (INS)	35	35
	Vacant, developable (VAC)[a]	5	Consistent with the underlying land use designation
	Open Space (OSP), undevelopable – Parks, greenways, natural areas, private [b]	5	5
	OSP, undevelopable – WPA, setbacks, Natural Resource Preservation Overlay, wetlands [b]	4	4
	Transportation (Oregon Department of Transportation corridor)	46	46
	Basalt Creek/rural residential	7	7

a. *Vacant land use reflects area with new or infill development potential. Future development conditions assume development of vacant lands consistent with their associated planning district designation.*

b. *Open space land use reflects area with no foreseeable development potential.*

Future growth for purposes of evaluating stormwater drainage infrastructure is based on projected development (i.e., vacant lands) (see Figure 2-4). Future industrial, primarily in the western half of the city, and commercial and multi-family residential development, is expected. Residential infill development is also anticipated. For the Basalt Creek planning area, future growth and development is expected but the timeframe is unknown. For purposes of this plan, future development conditions were not evaluated or assessed hydrologically for this area.

2.6 Climate and Rainfall

The northern Willamette Valley climate is characterized by cool wet winters and warm dry summers. Most rainfall occurs between October and April. On average, November is the wettest month with an average of 9.3 inches of rainfall. July and August are the warmest and driest months with average high temperatures above 80 degrees Fahrenheit and less than 1 inch of rain per month. The average annual precipitation for the Portland metropolitan area ranges from 37 to 43 inches, with an average of 1.8 inches of snowfall annually.

In December 2015, the Portland metro area experienced a large rainfall event that delivered more than 5 inches of rain over a 3-day period and 2.81 inches in one 24-hour period. This event was estimated to be between a 50- and 100-year frequency event because of the intensity and nature of the rainfall. These “severe” events are expected to occur more frequently as the earth undergoes climate change.

2.7 Natural Systems

Tualatin drains to six major waterbodies: The Tualatin River, Cummins Creeks, Hedges Creek, Nyberg Creek, Saum Creek and Basalt Creek. These waterbodies and their associated drainage basins are shown on Figure 2-5. Cummins Creek, Hedges Creek, Nyberg Creek, and Saum Creek are tributaries to the Tualatin River. Basalt Creek is a tributary to the Willamette River. Contributing city area and planning area by drainage basin is summarized in Table 2-3.

Table 2-3. Major Drainage Basins and Contributing Drainage Area

Major Drainage Basin	City Area (ac)	Planning Area (ac)
Tualatin River (direct)	906	0
Cummins Creek	313	13
Hedges Creek	2,277	288
Nyberg Creek	863	0
Saum Creek	514	34
Basalt Creek	170	318

ac = acre

Each major waterbody has unique characteristics and is being impacted by development in different ways. In general, the natural systems within the city are considered highly modified. They have been affected by historic development activities conducted without the inclusion of stormwater management facilities to address water quality and increased flow and runoff volumes. An overview of stream channel conditions is provided in Section 5.

Ownership of the natural system has been identified based on adjacent property ownership (Figure 2-5). Ownership status limits activities the City can conduct to maintain and preserve the waterbody’s integrity.

2.8 Stormwater Infrastructure System

The City manages approximately 93 miles (approximately 486,800 linear feet [LF]) of stormwater drainage pipe and 1.5 miles (7,700 LF) of roadside drainage ditches. There are six major receiving waters located throughout the city. As a result, most of the City’s drainage infrastructure consists of small dispersed systems rather than large trunk lines. There are 386 mapped outfalls from the piped systems to receiving waters. The majority of pipe in the city is 12-inch concrete pipe.

Tables 2-4 and 2-5 summarize pipe characteristics and major drainage system features in the city as mapped in GIS. Major drainage features include manholes, catch basins, discharge points (outfalls), public water quality facilities (swales), public ponds (detention, dry ponds), and underground injection control wells. Figure 2-6 provides an overview of the stormwater collection and conveyance system.

Table 2-4. System Asset Inventory–Pipes and Open Channels, Public (mapped in GIS)

Diameter	Length (ft)
Not documented in GIS	11,684.1
0-6	27,891.1
8-12	244,648.3
14-18	102,535.4
20-24	57,762.1
27-30	21,681.0
36	14,519.0
42	1,146.2
48	3,952.9
54	0.0
60	728.4
66	0.0
72	229.2
Mapped Open Channels	7,735.3
Total (Pipe)	494,513.0

Table 2-5. Major Drainage Features (Counts)

Major Drainage Feature	Number)
Manholes	1,929
Catch basins	3,072
Outfalls	386
Public water quality facilities (swales)	32
Public ponds (detention, dry ponds)	52

Although most development in the city has occurred over the last 25 to 30 years, proactive system inspection and maintenance is needed to ensure continued performance. The City currently has limited information regarding underground utility condition and age. As the city continues to grow and expand, pipe and infrastructure will be added to the City's asset inventory that will need to be managed and maintained.

2.9 Water Quality and Regulatory Drivers

The Oregon Department of Environmental Quality (DEQ) is responsible for implementing provisions of the federal Clean Water Act (CWA) pertaining to stormwater discharges and surface water quality. DEQ conducts permitting for activities that discharge to surface waters, establishes water quality criteria for waterbodies based on designated use, and conducts studies and evaluations to determine whether a waterbody adheres to water quality standards. Water quality is a specific focus of this SMP.

2.9.1 National Pollutant Discharge Elimination System (NPDES) Permit Program

The NPDES Municipal Separate Storm Sewer permit program regulates discharges of stormwater to receiving waters from urban areas and requires permitted municipalities to develop and implement stormwater control measures to address stormwater quality.

The City is a co-implementer on the CWS watershed-based NPDES permit, along with 12 other jurisdictions in Washington County, for managing stormwater runoff. CWS' NPDES permit was reissued in May 2016 for a 5-year permit term.

Implementation of CWS' NPDES permit is outlined in the CWS SWMP. Stormwater activities or best management practices (BMP) are outlined to address the elements of the permit including public education, public involvement, illicit discharge detection/elimination, construction site management, post-construction stormwater management, industrial/commercial facility inspections, good housekeeping practices for municipal operations, and operations and maintenance (O&M) activities for stormwater management facilities.

In addition to the permit elements listed above, the reissued NPDES permit requires CWS and co-implementers to prepare a stormwater retrofit strategy, prepare a hydromodification assessment (to address instream channel erosion and modifications), and develop TMDL pollutant load reduction benchmarks. These additional requirements prompted the City to incorporate stormwater retrofits for water quality improvement into its capital project development (see Section 3.1.1) and evaluate instream channel conditions to support future hydromodification assessments (see Section 5).

Coordination efforts between the City and CWS are identified in the SWMP and outlined in detail in IGAs between the City and CWA. The City maintains IGAs with CWS for erosion and sediment control and select system O&M activities.

2.9.2 Total Maximum Daily Load (TMDL) and 303(d) Listings

Section 303(d) of the CWA requires states to develop a list of water bodies that do not meet water quality standards. DEQ develops this list for Oregon, which is used to identify and prioritize water bodies for development of TMDLs. A TMDL identifies the assimilation capacity of a water body for specific pollutants and establishes pollutant load allocations for sources of discharge to the water body.

The Willamette and Tualatin rivers are the major receiving waters for Tualatin. These rivers and corresponding tributaries are on the 303(d) list for various parameters of concern and hold TMDLs for specific sources of pollutant loading. CWS is the identified discharge management agency in the Tualatin Subbasin and Willamette Basin TMDLs, and the City is identified as a contributing municipality associated with CWS. Table 2-6 summarizes the TMDL and 303(d) parameters relevant to the City.

Table 2-6. TMDL and 303(d) Summary for Tualatin					
Watershed/ Major Basin	Subbasin(s)	TMDL Year	Applicable TMDL parameters	TMDL surrogate parameters	Applicable 303(d) parameters [a]
Willamette River	Middle Willamette	2006	• Mercury • Bacteria (*E. coli*) • Temperature	• Effective shade (surrogate for temperature)	• Aldrin • Biological criteria • DDT/DDE • Dieldrin • Iron • Polychlorinated biphenyls (PCB)
Tualatin River	Tualatin	2001 and 2012 (update)	• Bacteria (*E. coli*) • Chlorophyll a • pH • Dissolved oxygen • Temperature	• Total phosphorus (surrogate for chlorophyll a and pH) • Total suspended solids (equivalent parameter for settleable volatile solids [SVS], a surrogate for dissolved oxygen) • Effective shade (surrogate for temperature)	• Ammonia • Biological criteria • Copper • Iron • Lead • Zinc

a. *The 2016 303(d) list for Oregon was approved by DEQ in January 2019. It is the effective list for Oregon.*

2.10 Stormwater Program Management

Stormwater program management includes maintenance, program operations, and program funding as described in the following subsections. This SMP includes an evaluation of maintenance activities and recommended program improvements to supplement capital project needs (see Section 6).

2.10.1 Maintenance Obligations

Maintenance of the City's assets is important to ensure that the full life expectancy is realized. The City allocates six, full-time equivalent (FTE) staff for utility system maintenance in the Public Works Department. Utility system maintenance includes stormwater system maintenance. Utility maintenance crews share responsibilities for multiple utility and infrastructure assets.

As mentioned, the City is a co-implementer on the CWS watershed-based NPDES permit for managing stormwater runoff. Maintenance obligations are outlined in the effective SWMP, dated 2016. Maintenance activities occur on a scheduled basis and in response to citizen and staff requests and are documented annually in the CWS stormwater annual report. Typical maintenance activities include:

- Pipeline inspection (CCTV) and cleaning
- Manhole repair
- Catch basin cleaning
- Public water quality facility inspection and maintenance (water quality manholes, vegetated stormwater facilities, proprietary filter systems). Public ponds are not routinely inspected and maintained by the City.
- Street sweeping

2.10.2 Program Operations

Programmatic stormwater activities are generally implemented to comply with NPDES permit requirements and may be conducted by utility maintenance staff or engineering staff in the Public Works Department.

The City employs two full-time equivalent staff engineers, three engineering associates, and two engineering technicians all responsible for a variety of engineering needs, including stormwater. Program implementation is documented annually in the CWS NPDES annual report. Program activities conducted by the City include:

- Private stormwater quality facility tracking and inspections. Annual notices are mailed to facility owners reminding them of their maintenance obligations.
- Stormwater development review.
- Illicit discharge detection and elimination, including spill response.
- Promotion of regional stormwater public outreach materials and campaigns.

CWS performs erosion control inspections and enforcement on the City's behalf in accordance with an IGA.

2.10.3 Staffing and Program Funding

The stormwater program is funded primarily through stormwater utility fees. Utility fee revenue for the 2019–2020 fiscal year is approximately $3.4 million. CWS serves as the lead storm utility agency and implements selected program activities on behalf of the city.

A financial evaluation was conducted as part of this master planning effort to determine an annual stormwater utility rate and stormwater development charge (SDC) increase to support the proposed capital improvement program and ensure adequate funding levels to support implementation needs (see Section 8).

Staffing levels to implement the City's stormwater program are considered adequate to implement current project and program needs; however, additional staff resources will be required to ensure timely project implementation and expanded program activities. Detail related to current and projected staffing needs is included in Section 8.1.

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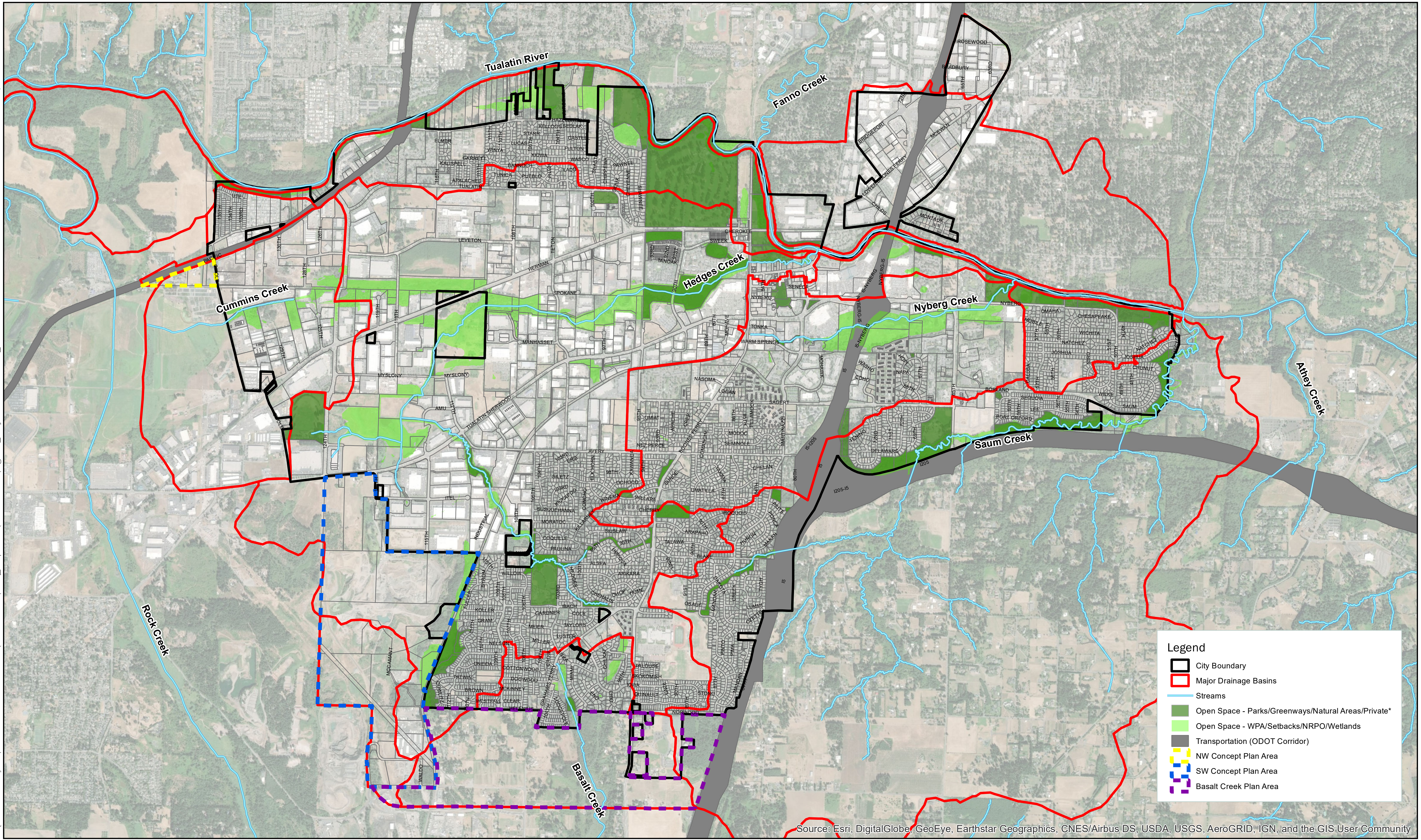

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Brown AND Caldwell

City of Tualatin

City of Tualatin

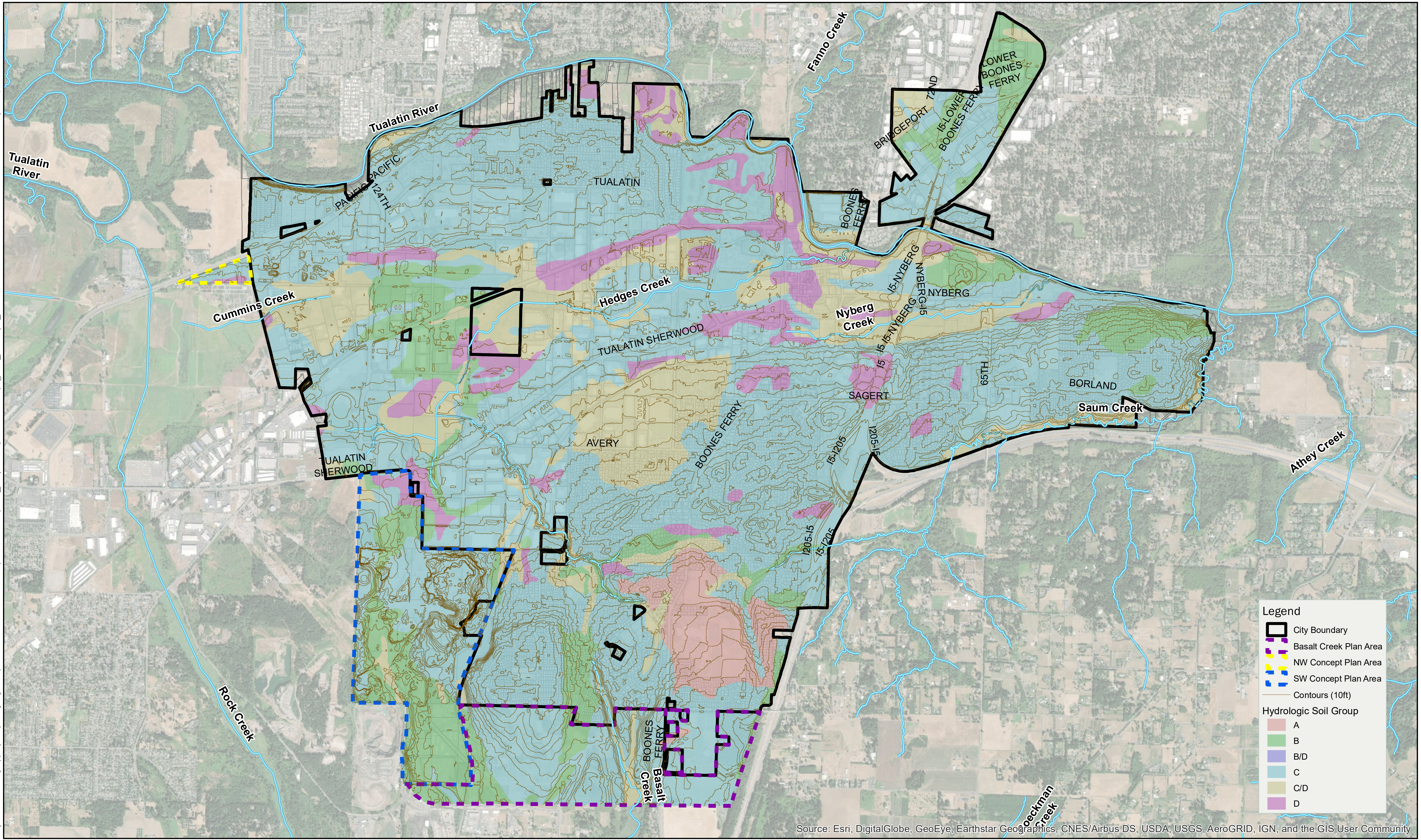
Stormwater Master Plan

Date: April 2019
Project: Project 149233

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 2-2

Project Area Overview



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Brown AND Caldwell

City of Tualatin

City of Tualatin

Stormwater Master Plan

Date: April 2019
Project: Project 149233

0 2,250 4,500 Feet

N

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 2-3

Topography and Soils

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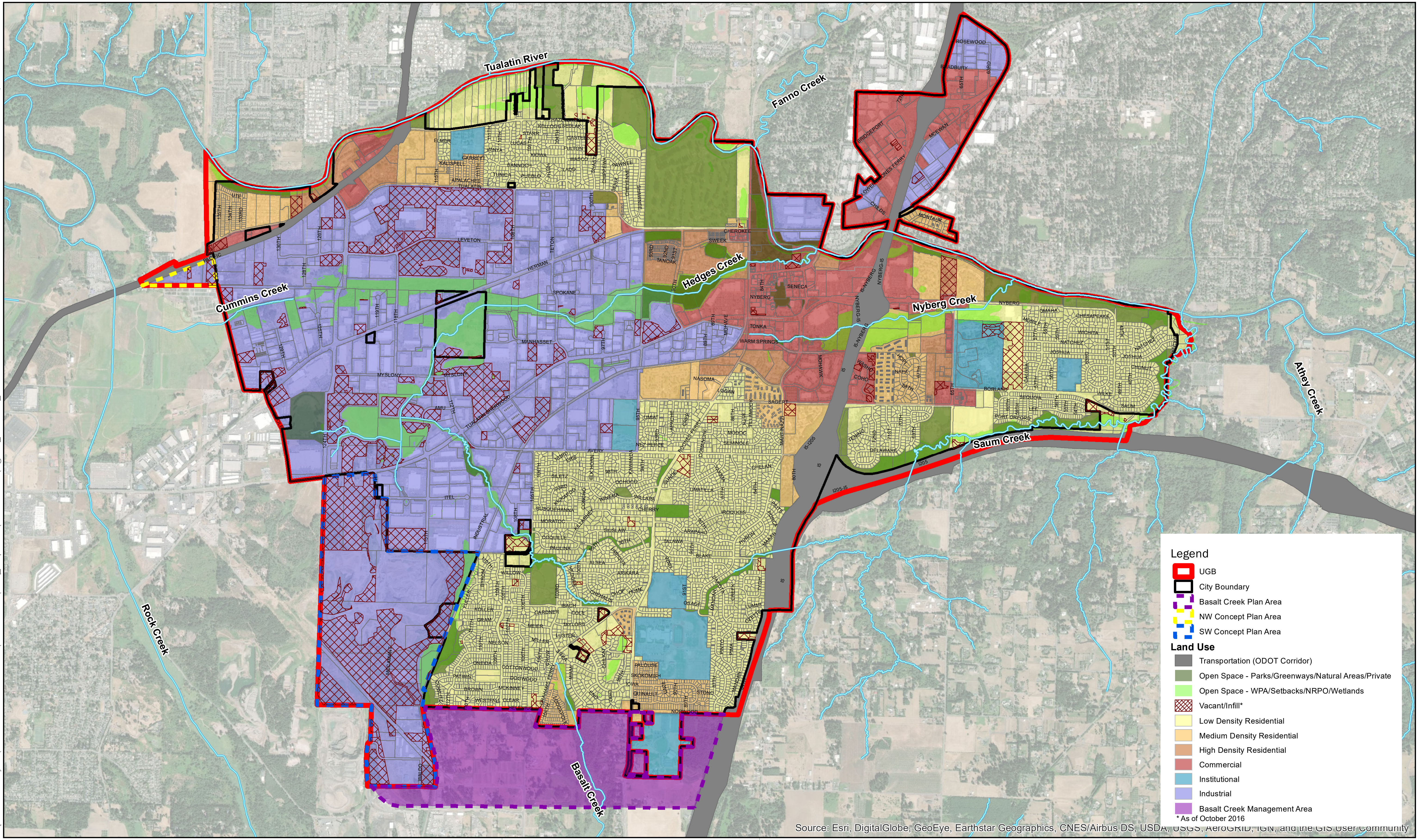

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City of Tualatin

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Stormwater Master Plan

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0 2,250 4,500 Feet

N

Notes:

1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 2-4

Land Use

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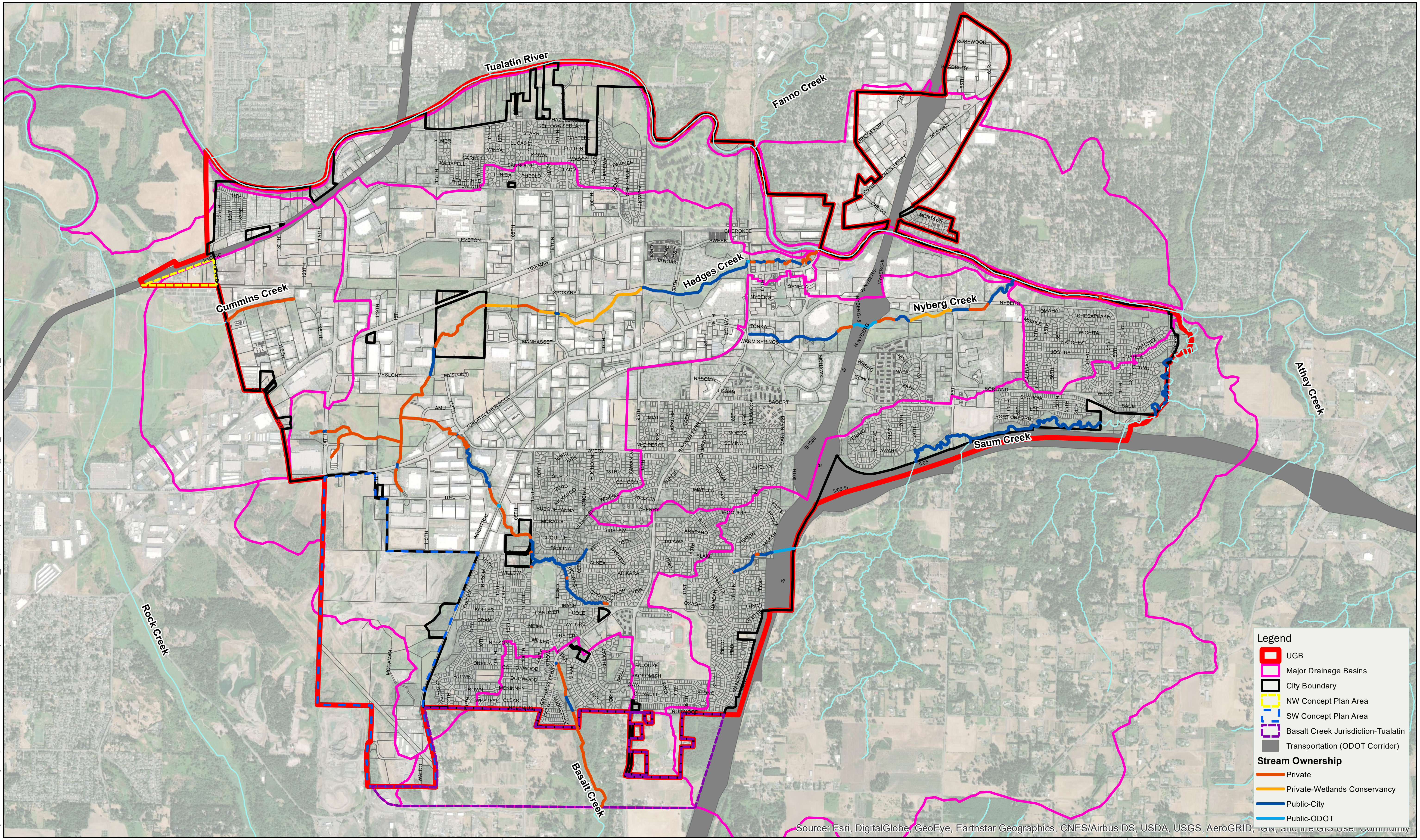

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City of Tualatin

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Stormwater Master Plan

Date: April 2019
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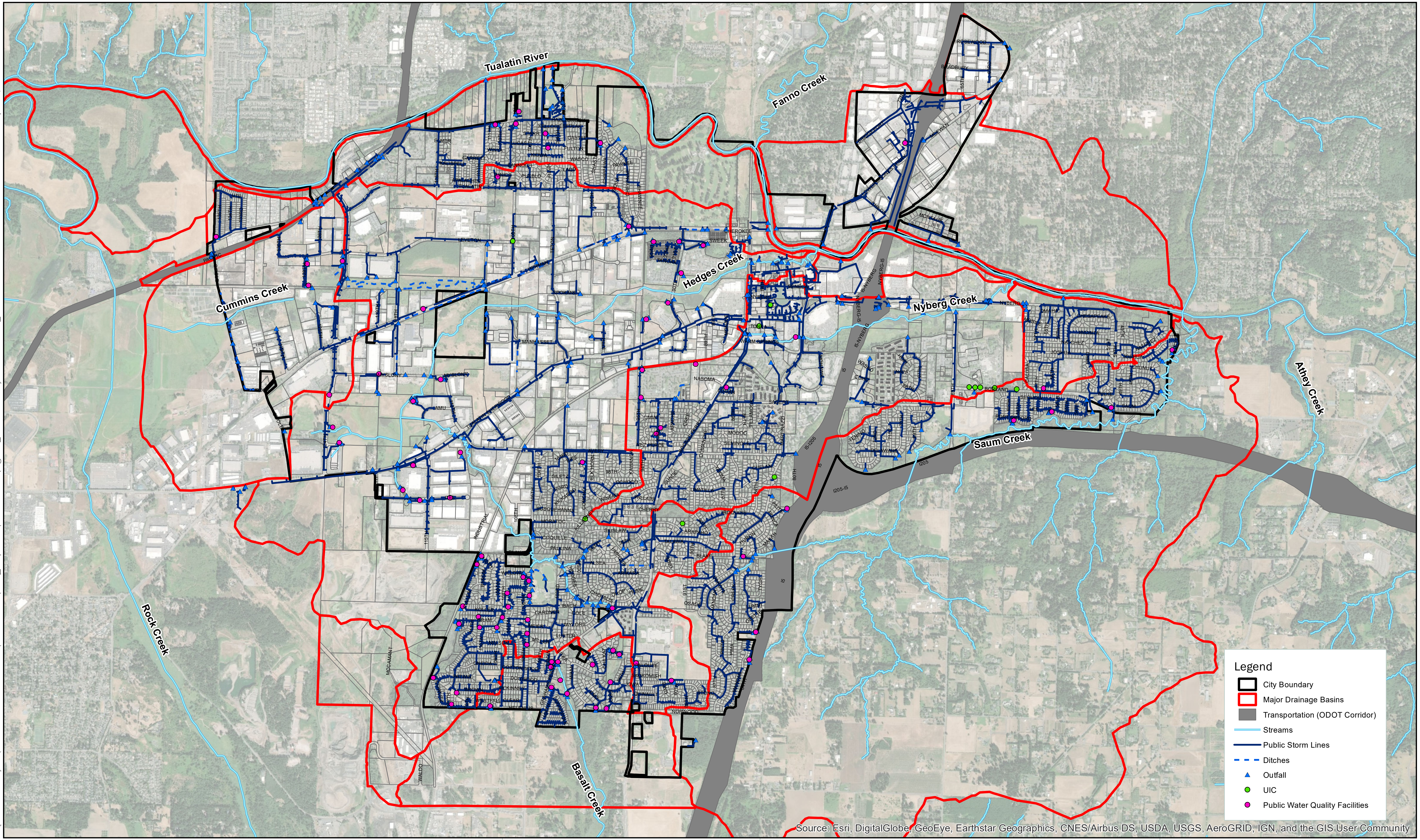
0 2,250 4,500 Feet

N

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 2-5

Stream Ownership



Brown AND Caldwell

City of Tualatin

City of Tualatin

Stormwater Master Plan

Date: April 2019

Project: Project 149233

Notes:

1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 2-6

Stormwater System Overview

Section 3

Planning Process

This section provides background information related to the initial identification of Stormwater Project Opportunity Areas, which were used to inform capital project and program development efforts. As part of this preliminary effort, areas requiring additional evaluation, including H/H modeling and/or field investigations, were also identified.

Stormwater Project Opportunity Areas were identified based on a variety of data collection and field reconnaissance efforts. This process allowed the City to focus resources and develop information for areas and projects likely to be prioritized in a capital improvement program.

Additional detail related to this process is provided inTM1, included in this SMP as Appendix B. Table 3-1 and Figure 3-1, both at the end of this section, summarize the Stormwater Project Opportunity Areas.

3.1 Project Needs Identification

Stormwater project needs were initially identified through a collaborative process with the City's engineering, planning, and operations staff to assess known stormwater system problems and identify areas where infrastructure improvement, replacement, or retrofit could address observed issues.

From June through December 2016, reconnaissance efforts were conducted to identify current stormwater problems. Questionnaires were distributed to engineering and maintenance staff to document the type and location of reported and observed stormwater system deficiencies. The City's GIS inventory of reported drainage problems was reviewed. Two site visits were conducted to confirm the source of reported stormwater problems and validate whether the problems should be evaluated and addressed in the context of the SMP. Stormwater problem areas identified based on a stream capacity issue (bank overtopping) were generally omitted as a project opportunity, as stream capacity and natural system flooding was not an SMP objective.

Reported stormwater problems and project needs were consolidated by geographic area into defined Stormwater Project Opportunity Areas.

3.1.1 Water Quality Opportunities

Throughout this SMP planning process, expanded coverage of water quality treatment was a priority. An assessment of water quality project opportunities and potential water quality retrofits was conducted to supplement identified stormwater problem areas and project needs. Detail related to this effort is provided in Appendix B.

In the city and throughout the CWS NPDES permit coverage area there is increased emphasis on methods for improving stormwater quality. One method involves identifying opportunities to install water quality treatment facilities, particularly in developed areas of a city with high pollutant load potential (by land use) and limited potential for development and redevelopment (such that treatment requirements per development standards would be triggered). Such water quality retrofits can address stormwater regulatory requirements under the CWS NPDES permit and improve stream health and habitat citywide. identifying retrofit opportunities can be challenging, particularly in developed areas where space is limited for installing above ground, vegetated treatment facilities as promoted in the NPDES permit.

The initial assessment of water quality project opportunity areas included a review of water-quality-related capital improvement projects per the City's 2017-2021 Capital Improvement Plan and review of available vacant/public lands that would support a new treatment facility. Available public lands are considered those not subject to the Tualatin City Charter, Chapter XI provisions, and generally included larger public parking areas or areas within the ROW[1]. Locations associated with high pollutant generating land use (i.e., industrial or commercial) and high imperviousness were prioritized for project development.

Reported capacity and maintenance-related stormwater problem areas were also reviewed to see if an integrated approach to stormwater management (i.e., installing water quality facilities to also mitigate stormwater runoff) could help address the reported issue (see Section 6).

Table 3-1 identifies Stormwater Project Opportunity Areas resulting from the assessment of water quality project opportunities. Water quality retrofit potential was identified for each opportunity area.

3.1.2 System Modeling Needs

Five stormwater problem areas were identified that required hydraulic modeling of the storm system to inform the source of capacity limitations and associated project development. These areas included:

1. Manhassat Drive (Stormwater Project Opportunity Area 4)
2. Boones Ferry Road at Tonka Road (Stormwater Project Opportunity Area 5)
3. Herman Road (Stormwater Project Opportunity Area 7)
4. Sagert Street at the Shenandoah Apartments (Stormwater Project Opportunity Area 9)
5. Mohawk Apartments at Warm Springs Road (Stormwater Project Opportunity Area 10)

Detail related to the H/H modeling methodology, model results, and associated project development is included in Section 4.

3.1.3 Stream Assessment Needs

Bank erosion, channel incision, sediment accumulation, and invasive vegetation are reported in reaches of the City's open channel conveyance system. To investigate these issues and develop a baseline assessment to evaluate stream condition in the future, a field stream assessment was initiated in September 2017.

The City identified and prioritized reaches of Suam Creek, Hedges Creek, and Nyberg Creek under "public ownership" (see Figure 2-5) that have not been previously evaluated but where there are reported problems.

Detail related to the stream assessment effort and associated project and program development is included in Section 5.

[1] Tualatin City Charter, Chapter XI limits the use of publicly owned parks, greenways, and natural areas to be used outside of their original intent without a public vote. The City has interpreted this provision to include using the property to facilitate installation of stormwater facilities.

3.2 Project Development Workshop

A project development workshop was held in October 2017 to finalize project development priorities and identify program needs/activities. Stormwater Project Opportunity Areas stemming from the preliminary project identification effort were presented and initial project concepts discussed.

Results from the hydraulic modeling effort were reviewed to confirm locations where flooding and surcharging have been observed. Project alternatives were discussed with the City to determine preferences related to routing and system configuration (i.e., piped versus open channel). Preliminary results from the stream assessment effort were also reviewed to validate project needs.

In some cases, an identified Stormwater Project Opportunity Area was determined to be better addressed as part of a routine maintenance activity instead of through implementing a standalone capital project. Relevant program needs for the City were discussed and included a pipe repair and replacement program, public water quality facility maintenance programs, and a stream vegetation management program. Section 6 addresses maintenance-related project and program needs.

During the workshop, City staff requested additional water quality-related project opportunities be considered and evaluated. As a result, the water quality opportunity areas were revisited, and additional public properties were identified, specifically parking lots, that could support water quality or LIDA facility installation. Site visits were conducted November 10 and December 17, 2017, to verify opportunities for additional water quality retrofit applications.

3.3 Results

Table 3-1 documents the list of final Stormwater Project Opportunity Areas used to develop capital projects and programs for this SMP. Figure 3-1 identifies each Stormwater Project Opportunity Area by ID (a numeric identifier) and primary project category—capacity/infrastructure need, erosion control, maintenance/condition assessment, and water quality. Multiple project categories may be relevant to one project opportunity, but the predominant category was used for mapping.

Twenty-six individual Stormwater Project Opportunity Areas and three citywide opportunities were identified, which reflects an expanded list of water quality retrofit locations following the project development workshop. Table 3-1 also includes a summary of the citywide preliminary project/program concepts.

It should be noted that not all Stormwater Project Opportunity Areas result in a capital project or program recommendation. Follow-up site visits conducted in November and December 2017 determined that two potential water quality retrofit locations were not viable for a facility installation. Additionally, City staff determined that the ability to retrofit select core parking areas of the City would require Board approval, and these areas should not be considered for proposed projects at this time.

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Table 3-1. City of Tualatin Stormwater Project Opportunities

SW Project Opportunity Area ID	Location	Basin/ Waterbody	Problem/ Project Category	Source	Water Quality (WQ) Retrofit Opportunity	Problem/Project Area Description	Preliminary Project Concepts and Observations (per site visits)	Additional Data Collection/City Input (following Project Development Workshop)	Project Development		
									Project Need	Programmatic Activity	No Project

1	Martinazzi Ave (near Tualatin-Sherwood Rd)
	Tualatin Sherwood Ave (near Martinazzi Ave)
		Nyberg Creek	• Maintenance/ Condition Assessment
			• Capacity (pipe grade)
				• Staff Questionnaire
				• City GIS
						• Over curb flooding in heavy rain events. Flooding originally thought to be a backwater issue from Nyberg Creek.
						• System includes high flow bypass pipe down Martinazzi to Izzy's Pond (12") and a low flow pipe (42") to the downstream end of culvert under Martinazzi that is almost fully submerged.
						• Anticipated to be addressed per current CWS project to remove sediment and improve capacity in Nyberg Creek.
							• Flat grade and submerged pipe attributes to sediment accumulation in the pipe down Martinazzi
							• Alternatives include:
							  • Pipe replacement (parallel pipe) or reconfiguration/rerouting.
							  • Development of an asset management/maintenance related CIP for continuous sediment removal.
								• Given orientation and current backwater, more frequent maintenance likely only means to address this problem area in the near term.
								• City requested expanded model development from Martinazzi to Nyberg Road along Nyberg Creek. Follow up modeling (initiated July 2018) conducted to determine project need.
								• Programmatic activities to be included in Master Plan and rate evaluation.
									TBD	X	

2	Venetia WQ Facility (Lee between 56th and 57th)	Saum Creek	• Maintenance/ Condition Assessment	• City GIS		• Facility overgrown with large bushes and trees but functional.
						• As-builts available. Facility design is a U-shaped swale with a total flowline of 172 LF and a slope of 1%. The bottom width of the swale is 4' with 4:1 side slopes. Top width is 15' and the water treatment level is 5.7".
						• Flow control MH installed directly upstream of the swale with a 24" bypass directly to the creek for high flow events.
							• No access to inlet/outlet.
							• Limited maintenance access; the existing access path is partially washed out.
							• Steep grade. High flow bypass outfall should be checked and repaired as needed
							• Project needs include:
							  • vegetation trim and thinning, removal of invasives
							  • replanting as needed
							  • regrading as needed
								Keep as a maintenance-related project.	X		

3	Blake St outfall at Saum Creek	Saum Creek	• Erosion Control
			• Maintenance (Debris accumulation)
				• City GIS		• Outfall experiences bank erosion (citizen complaints). Further erosion could impact the adjacent home.
						• Culvert under Blake may be undersized and cause backwater upstream.
							• The bank is steep and appears to be unstable and eroding.
							• Bank instability may not solely be due to the outfall. Adjacent bank instability and groundwater seepage was observed 100' downstream. Further geotechnical investigation may be warranted.
							• The upstream system appears in good order.
							• Project needed to retrofit existing outfall to creek, which is hanging out over the creek and exposed and minimize erosion of the channel.
							• Bank rehabilitation may include:
							  • rock buttress
							  • pillow wall with plantings to stabilize bank
							  • other based on geotechnical guidance
								• Storm pipe upstream of outfall requires replacement due to structural deficiencies.
								• Include outfall pipe replacement (existing failure) from road and private fence replacement in cost estimate.
								• Cost estimate to include geotechnical evaluation of stream reach.
									X		

4	Manhasset Dr (near 10550 SW Manhasset Dr)	Hedges Creek	• Capacity/ Infrastructure Need	• Staff Questionnaire- • Storm Area Hot Spots • City GIS • Stormwater CIP • WQ retrofit evaluation	X	• Frequent flooding of drainage channel between private properties from T-S Rd to Manhasset. • Drainage channel has limited capacity and observed debris accumulation. • Preliminary modeling indicates that the open channel is undersized for the contributing drainage area. • Some contributing pipes are undersized and surcharging during the 25-yr design storm. • Retrofit (WQ) opportunity - adjacent undeveloped land that has transportation and warehouse land draining to it. • No city easement exists along alignment.	• CIP needed to alleviate private property flooding and reconfigure collection system • System configuration options presented during the workshop include maintaining the open channel and piping the entire alignment.	• Modified system hydrology needed on upstream industrial parcel. The NE corner of the parcel does not discharge to the system. BC to evaluate with updated hydrology. • Piped system requires less maintenance and is preferred. • System surcharging is permissible due to flat grade and areas of backslope on the discharge pipe.	X		

Table 3-1. City of Tualatin Stormwater Project Opportunities

SW Project Opportunity Area ID	Location	Basin/ Waterbody	Problem/ Project Category	Source	Water Quality (WQ) Retrofit Opportunity	Problem/Project Area Description	Preliminary Project Concepts and Observations (per site visits)	Additional Data Collection/City Input (following Project Development Workshop)	Project Development		
									Project Need	Programmatic Activity	No Project

5	Boones Ferry Rd (19417 SW Boones Ferry Rd)	Nyberg Creek	• Capacity/ Infrastructure Need
			• Maintenance (gravel ballast)
				• Storm Area Hot Spots
				• City GIS
					X	• Problem location extends down Boones Ferry, the railroad culvert behind Jiffy Lube, and west along Tonka Avenue. Specific problem locations include:
						  • The inlet along the RR tracks (maintenance issue). Gravel is transported and redeposited downstream.
						  • StormFilter catchbasins along Boones Ferry are located at a roadway sag and clog, resulting in flooding.
						  • The conveyance system along Tonka, Warm Springs and Boones Ferry contributes to flooding.
							• CIP needed for source control and improved conveyance.
							• Gravel transportation mitigation needed to control railroad ballast.
							• Site visit confirmed two existing offline, single cartridge configuration of Storm Filter catchbasins. Additional sediment control or relocation may be needed to improve StormFilter performance.
							• Rerouting of conveyance on Warm Spring, Tonka and Boones Ferry may improve conveyance and alleviate flooding.
							• Preliminary modeling and system configuration alternatives presented during Workshop include revisions to the RR conveyance channel and Boones Ferry routing alternatives.
								• City requested expanded model development from Martinazzi to Nyberg Road along Nyberg Creek (initiated July 2018), which may impact project development.
								• StormFilter relocation needed.
								• Due to project size and scope, project development may require separate projects and/or phasing.
								• Follow up site visit 12/14/17 indicates the most viable option for a StormFilter is upstream along Boones Ferry.
									X		

6	Alsea/BF Rd 99th/Siuslaw Greenway	Hedges Creek	• Capacity/ Infrastructure Need • Water Quality	• Staff Questionnaire • WQ retrofit evaluation	X	• Dual corrugated pipe has the bottom rusted out. No apparent capacity deficiency. • High levels of sediment accumulation are observed. • Retrofit (WQ and FC) opportunity- This long linear greenway may provide an opportunity for WQ treatment for contributing drainage area (City confirms ok per charter).	• Project to include replacement of parallel pipes from Boones Ferry to MH upstream of parallel pipes • Project to include sediment trap. • Area is upstream of observed instream erosion at Alsea Ct. Regrading/amending channel between Siuslaw Ln and 98th Ave would improve downstream erosion issues.	• Include pipe replacement, sediment trap, and bioswale in cost estimate. • Project meets retrofit requirement and promotes stormwater infiltration/retention. • City to review upstream system to define upstream limit of replacement.	X		
7	Herman Rd	Hedges Creek	• Capacity/ Infrastructure Need	• Staff Questionnaire • WQ retrofit evaluation	X	• System has flat grade. Half the road drains to roadside ditch and the other half to a ditch along railroad ROW. • System lacks required drainage infrastructure. City wishes to install piped/below ground infrastructure. • Survey shows negative pipe slopes for the culverts passing under Herman Road. Survey also indicates pipes under RR are deep relative to upstream and downstream pipes. • Preliminary modeling indicates that culverts crossing Herman Road leads to backwater effects and flooding in the ditch/culvert system on the north side of Herman Road.	• CIP needed to install additional conveyance infrastructure. • Preliminary modeled alternatives suggest the system will backwater upstream of the railroad crossing. • Piping to be sized with maximum slope possible to limit sedimentation • Potential water quality retrofit locations at SE corner of Herman Road and 95th Avenue.	• Modified system hydrology needed. Golf course does not discharge to system. • Preferred configuration is piped system in middle of roadway. • Culverts under tracks are frequently maintained. • System surcharging is permissible due to flat grade. • No water quality treatment needed/not a retrofit opportunity now. Stormwater treatment will be accommodated as part of the roadway widening.	X		

8	Curves at Blake/105 and 108th	Hedges Creek	• Capacity/Infrastru cture Need
			• Erosion
				• Staff Questionnaire		• Roadway lacks collection system and pedestrian access. City is currently in planning stages for roadway update (concept plan in place) but no budget for project yet.
						• Culvert alignment may play a role in design and cost estimate.
						• Current drainage from Coquille/Paulina and 105th is an open channel ditch to culvert inlet.
						• Specific problem locations include:
						  • Stream channel experiences 90° bends on both sides of culvert.
						  • Culvert is undersized
						  • Existing roadway embankments are steep and drainage updates are needed for the roadway.
							• Culvert design to incorporate a sizing and length based on the hydrology and ideal alignment.
							• Observed (during stream assessment) retaining wall deficiencies along the roadway. Assume improvements as part of roadway redesign and not culvert replacement.
								• Per Oregon Department of Fish and Wildlife (ODFW) feedback (1/25/17) culvert fish passage design not necessary.
								• Culvert sizing and construction estimate needed as part of the CIP. Roadway drainage to be addressed with roadway update.
								• Assume configuration of culvert to align with historic channel orientation and not current orientation.
								• Culvert to be sized based on 100-yr flows at point of inlet.
									X		

Table 3-1. City of Tualatin Stormwater Project Opportunities

SW Project Opportunity Area ID	Location	Basin/ Waterbody	Problem/ Project Category	Source	Water Quality (WQ) Retrofit Opportunity	Problem/Project Area Description	Preliminary Project Concepts and Observations (per site visits)	Additional Data Collection/City Input (following Project Development Workshop)	Project Development		
									Project Need	Programmatic Activity	No Project
9	Sagert St. - Shenandoah Apts (Sandalwood)	Nyberg Creek	• Erosion Control • Capacity/Infrastructure Need	• Storm Area Hot Spots • WQ retrofit evaluation	X	• Reported flooding during Oct and Dec 2015 storms. • Retrofit (WQ) opportunity by converting existing open channel to WQ facility. • Preliminary modeling indicates that the existing pipes upstream of the open channel are undersized and are surcharging during the 25-yr design storm, but no flooding is reported.	• System flooding may be due to debris from nearby tree limiting capacity of ditch inlet. • Limited pipe cover through greenspace. • Channel sloughing observed upstream of Sagert St. • WQ and detention should be incorporated into this project if possible (project location is upstream of WQ Opportunity Area #10).	• City easement exists. • CIP development to be completed independent of Nyberg system. Surcharging is acceptable. • Relocate ditch inlet (away from tree). • Maintain open channel conveyance options to qualify as a water quality retrofit.	X		

10	Mohawk Apts	Nyberg Creek	• Capacity/ Infrastructure Need
			• Maintenance/ Condition Assessment
				• Storm Area Hot Spots		• Conveyance capacity affecting Opportunity Area #5.
						• Inlet behind Mohawk Apts is inundated, resulting in overland flow through adjacent property and flooding Tonka and Warm Springs at the Elks Lodge.
						• City is unaware of any easements that may facilitate correcting the issue.
							• Limited freeboard available prior to overtopping at the inlet. Grate structure installed at inlet likely reducing capacity.
							• Alternatives include:
							  • Update/replace inlet and embankment to reduce/remove flooding
							  • Pipe open section through apartments and remove inlet
							  • Update both inlet and channel to enhance natural function/remove invasive vegetation
								• City unable to access pipe upstream of open channel for CCTV. Need to include CCTV cost into CIP development.
								• CIP to include installation of access locations (manholes) along piped system upstream of open channel.
								• CIP to include replacement of ditch inlet at downstream end of open channel and corrugated metal pipe downstream of open channel.
								• City to confirm easement along open channel alignment.
								• City prefers piping over maintaining open channel.
									X		

11	Piute Ct. WQ Facility	Saum Creek	• Maintenance/ Condition Assessment	• Storm Area Hot Spots		• Public WQ facility is failing. Sediment and invasive vegetation accumulation. • As-builts available. Facility design is approx. 7' deep, 400 square foot (sf) bottom, 3:1 side slope. • No access road. Easement status is unknown.	• Site visit was unable to locate outlet structure. System appears to discharge towards I-205. • Potential maintenance access along backside of facility. Installation of access road needed. • CIP to include facility regrading with sediment and vegetation removal and replanting. • Existing easement available between two houses on Piute Ct. but does not appear to be established or used.	• Keep as a maintenance project. • The outfall structure should be inspected and repaired as needed. • City owns easement between two private properties off Piute Ct. Assume construction of a permanent access road off Piute Ct.	X		

12	Sequoia Ridge WQ Facility	Saum Creek	• Maintenance/ Condition Assessment	• Stormwater CIP		• Facility is overgrown with malfunctioning outlet structure and standing water.
						• As-builts available. Facility design reflects pond volume of 14,250 cubic feet (cf) but was built to 15,500 cf. Pond bottom is approx. 4,000 sf and 5' deep with side slopes of 3:1. Facility was designed in 1997.
						• Outlet structure has a 2" orifice for low flow and a high flow inlet to bypass low flow orifice.
						• Trail connects facility to Saum Creek, resulting in increased public attention.
							• Large cottonwood trees need to be removed
							• Outfall structure needs engineering review.
							• Due to the standing water, there is little beneficial vegetation and will likely need to be fully replanted.
							• As-builts reference recommended maintenance requirements including sediment removal once it exceeds 6" in depth. Mow 2x/yr. Watering in times of drought. Inspections 3x/yr.
							• Project needs include:
							  • Replacement of outlet structure
							  • Removal of trees
							  • Amendment of soils
							  • Replanting of vegetation
								• Keep as a maintenance project.
								• The outfall structure should be inspected and repaired as needed.
									X		

13	Sweek Dr WQ Facility	Hedges Creek	• Maintenance/ Condition Assessment	• Stormwater CIP		• Facility is overgrown. • No as-builts available.	• Large cottonwood trees need to be removed, • No outlet structure observed, and facility appears to freely drain. • Project needs include: • Removal of trees	• Keep as a maintenance project.	X		

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Table 3-1. City of Tualatin Stormwater Project Opportunities

SW Project Opportunity Area ID	Location	Basin/ Waterbody	Problem/ Project Category	Source	Water Quality (WQ) Retrofit Opportunity	Problem/Project Area Description	Preliminary Project Concepts and Observations (per site visits)	Additional Data Collection/City Input (following Project Development Workshop)	Project Development		
									Project Need	Programmatic Activity	No Project
							• Amendment of soils • Replanting of vegetation				

14	Waterford WQ Facility	Hedges Creek	• Maintenance/ Condition Assessment	• Stormwater CIP
				• WQ retrofit evaluation
					X	• Maintenance needed due to sediment build up and limited access to outlet structure.
						• As-builts available. Facility is approx. 4' deep, 2,500 sf bottom. Facility was designed in 1993. Original design included WQ swale graded around the pond for preliminary treatment.
						• The existing outlet structure in the pond needs to be removed and relocated so maintenance can be performed during high water events.
						• Facility is upstream of observed instream erosion, so flow/volume control may benefit.
							• The WQ swale no longer exists and needs to be regraded into the facility.
							• No vegetation is visible and high sediment accumulation observed.
							• The inlet riprap needs to be replaced.
							• Project needs include:
							  • Relocation and redesign of outfall structure to maximize flow control.
							  • Invasive removal.
							  • Excavate and regrade WQ swale. Include amended soils and replant
							  • Replace inlet structure.
								• Flow control/flow duration sizing to be referenced in project description.
								• Project to assume maintenance consistent with other public WQ facility.
									X		

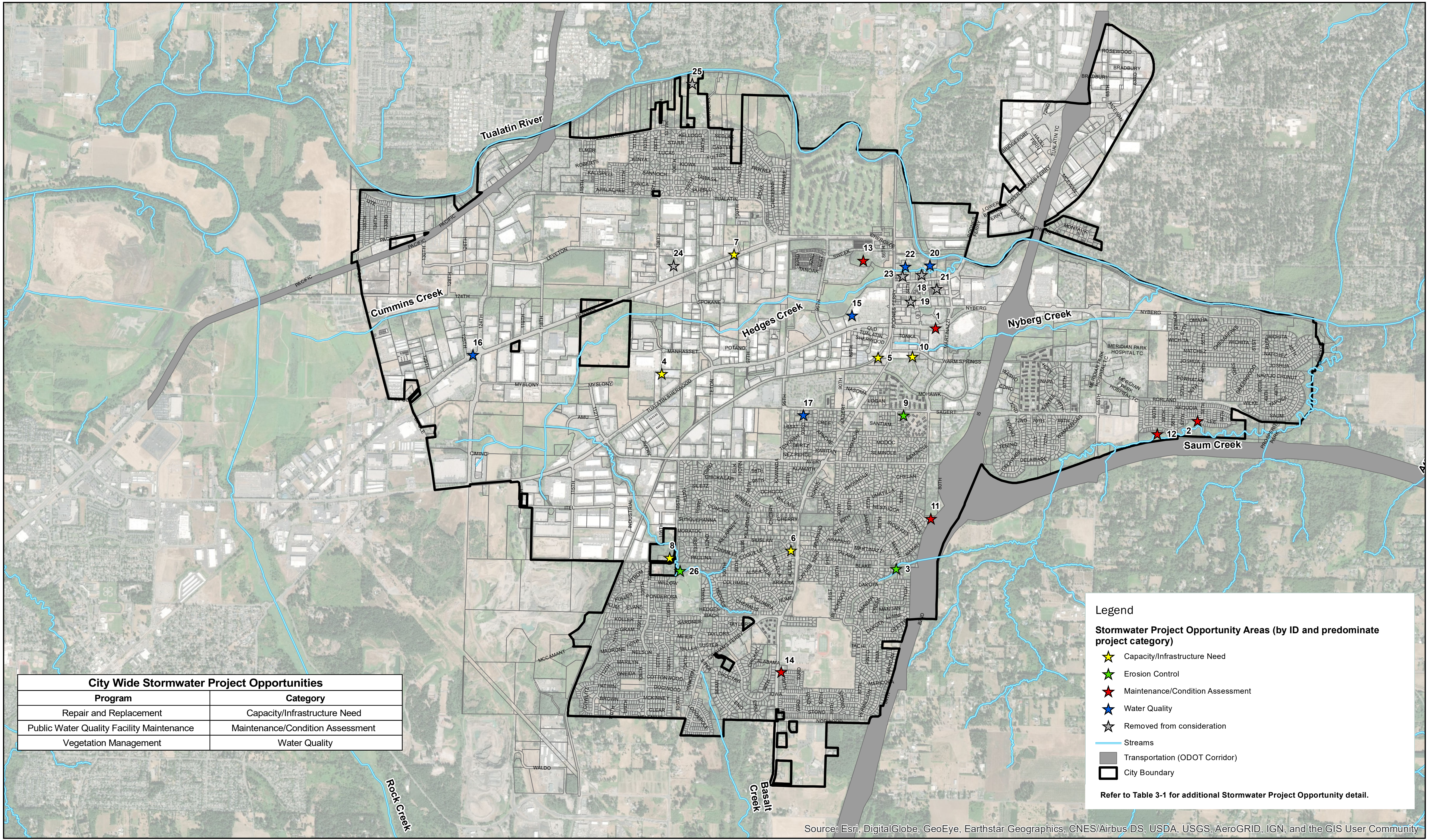
15	89th Ave/Tualatin-Sherwood Rd Stormwater Outfall	Hedges Creek	• Water Quality	• Stormwater CIP • WQ retrofit evaluation	X	• Project identified in City's 2017-2021 CIP. Project is a WQ manhole (MH) installation to prevent debris from discharging into wetlands. • CWS retrofit program driver. Per review of CWS Permit and SWMP, appears to be viable as an outfall retrofit project.	• Limited opportunity for green infrastructure or any facility with drop requirement. Water surface elevation in adjacent wetlands prohibits use of any facility with large internal drop requirement. • Due to a small head drop across the structure conveyance pipe from the structure and a new outfall may need to be constructed.	• Facility sizing and installation to be included as project	X		
16	125th to Herman Rd	Cummins Creek	• Water Quality	• Stormwater CIP • WQ retrofit evaluation	X	• Project identified in City's 2017-2021 CIP. Project is a WQ MH installation to treat 143 ac contributing area with no upstream treatment. • CWS retrofit program driver. Per review of CWS Permit and SWMP, appears to be viable as an outfall retrofit project. • Identifying catchment area challenging due to the railway along south side of SW Herman Road and unknown conveyance pathways.	• Limited opportunity for green infrastructure or any facility with drop requirement. Water surface elevation in adjacent wetlands prohibits use of any facility with large internal drop requirement. • Due to a small head drop across the structure conveyance pipe from the structure and a new outfall may need to be constructed. • Catchment delineation and facility placement to be determined during detailed design due to private property constraints.	• Facility sizing and installation to be included as project	X		
17	93rd Ave	Nyberg Creek	• Water Quality • Infrastructure need	• Staff Questionnaire • WQ retrofit evaluation	X	• Potential for green street pilot project to provide treatment in roadside planters to Avery St. • GIS indicates collection system exists, so no new infrastructure required.	• Current conveyance is provided in street side ditch primarily on the west side of 93rd. • Project to include curb and gutter where 93rd is currently unimproved. Roadside planters to be incorporated and sized based on the catchment area draining to the north end of the road to Avery.	• New project opportunity area following Workshop. • Project extends on the west side of 93rd Avenue to SW Umiat St. and on the east side to SW Tonopah St (one inlet will need to be removed in front of 20232 SW 93rd)	X		
18	Green Parking Lot (approx. 18725 SW Boones Ferry Rd)	Hedges Creek	• Water Quality • Capacity (bank overtopping)	• City GIS • WQ retrofit evaluation	X	• Potential WQ retrofit. • Reported flooding of lot due to proximity to Hedges Creek and floodplain. Flooding due to stream capacity issue and not to be addressed by Master Plan. • Vegetated swale (unmaintained) already exists adjacent to Hedges Creek; collecting parking lot runoff. • Parking lot properties are considered public but are governed by a separate board that oversees improvements.	• Per site visit, there are several locations where existing planters could be retrofit for additional WQ treatment. Would require relocation of inlet and potentially lose a parking stall depending on facility sizing needs.	• New project opportunity area following Workshop. • Area is already being treated by a water quality facility. Maintenance of the swale is recommended. • Follow up from City in December 2017 indicates the need for board approval to retrofit core area parking will present an implementation challenge. No dedicated project need now.			X

Table 3-1. City of Tualatin Stormwater Project Opportunities

SW Project Opportunity Area ID	Location	Basin/ Waterbody	Problem/ Project Category	Source	Water Quality (WQ) Retrofit Opportunity	Problem/Project Area Description	Preliminary Project Concepts and Observations (per site visits)	Additional Data Collection/City Input (following Project Development Workshop)	Project Development		
									Project Need	Programmatic Activity	No Project
19	Yellow Parking Lot (Seneca and 84th)	Hedges Creek	• Water Quality	• WQ retrofit evaluation	X	• Potential WQ retrofit. • Parking lot properties are considered public but are governed by a separate board that oversees improvements.	• Per site visit, there are several locations where the existing planters could be retrofit for WQ treatment. Would require relocating inlet and potentially losing a parking stall depending on facility sizing needs. • There are light poles in the planters.	• New project opportunity area following Workshop. • Follow up from City in December 2017 indicates the need for board approval to retrofit core area parking will present an implementation challenge. No dedicated project need now.			X
20	Juanita Pohl Parking Lot	Hedges Creek	• Water Quality	• WQ retrofit evaluation	X	• Potential WQ retrofit at City-owned, parking lot. • Significant impervious surface area and limited existing WQ treatment.	• Per site visit, there are several locations where the existing islands that could be retrofit for WQ treatment. Would require relocation of inlet and potentially lose a parking stall depending on facility sizing needs.	• New project opportunity area following Workshop.	X		
21	White Parking Lot	Hedges Creek	• Water Quality	• WQ retrofit evaluation	X	• Potential WQ retrofit. • Parking lot properties are considered public but are governed by a separate board that oversees improvements.	• Per site visit, parking lot currently drains to middle ditch/swale that could be retrofit to provide significant treatment. Some light grading, soil augmentation and planting would be needed. Existing inlets would need to be removed.	• New project opportunity area following Workshop. • Follow up from City in December 2017 indicates the need for board approval to retrofit core area parking will present an implementation challenge. No dedicated project need now.			X
22	Community Park Parking Lot	Hedges Creek	• Water Quality	• Site Visit	X	• Potential WQ retrofit at City-owned, parking lot. • Significant impervious surface area and limited existing WQ treatment.	• Per site visit, there are several locations where the existing islands that could be retrofit for WQ treatment. Would require relocation of inlet and potentially lose a parking stall depending on facility sizing needs.	• New project opportunity area following Workshop.	X		
23	Blue Parking Lot (Boones Ferry Rd and Tualatin Rd)	Hedges Creek	• Water Quality • Capacity (bank overtopping)	• City GIS • WQ retrofit evaluation	X	• Potential WQ retrofit. • Reported flooding of lot due to proximity to Hedges Creek and floodplain. Flooding due to stream capacity issue and not to be addressed by Master Plan. • Properties are considered public but are governed by a separate board that oversees improvements.	• Hedges Creek floods the parking lot during routine rain events. • Per site visit, standing water onsite and parking lot is at grade with Hedges Creek. • Not a recommended opportunity to retrofit for WQ.	• New project opportunity area following Workshop. • Follow up from City in December 2017 indicates the need for board approval to retrofit core area parking will present an implementation challenge. No dedicated project need now.			X
24	City Operations Yard	Hedges Creek	• Water Quality	• WQ retrofit evaluation	X	• Potential WQ retrofit at City-owned, municipal property. • Significant impervious surface area.	• Per site visit, the parking lot adjacent to Herman Road currently has WQ treatment. The parking lot adjacent to the building does not, and access was limited. • Little opportunity for WQ retrofit at this location.	• New project opportunity area following Workshop. • No recommended project per follow up site visits.			X
25	Jurgens Park Parking Lot	Tualatin River	• Water Quality	• Site Visit	X	• Potential WQ retrofit at City-owned, parking lot.	• Per site visit, there is little opportunity for a water quality retrofit due to catch basin placement. The northern portion of the parking area is already paved with porous pavers.	• New project opportunity area following Workshop. • No recommended project per follow up site visits.			X
26	Hedges Creek at SW 106th Ave and Willow Str	Hedges Creek	• Erosion Control	• Stream Assessment		• Active stream bank erosion occurring adjacent to, upstream, and downstream of an exposed sanitary manhole. • Separate evaluation conducted by the Park Department (Hedges Creek Stream Assessment, February 2018) also observed active erosion in vicinity.	• Limited upstream flow control results in high runoff velocities that appear to have eroded the stream channel. • Results of the Stream Assessment (Section 5 and TM3 of the SMP) outline specific observed conditions in reach.	• New project opportunity area following Workshop. • Project scope and cost information to be based on recommendations outlined in the Hedges Creek Stream Evaluation, February 2018. • Ongoing vegetation maintenance program needs.	X	X	

Table 3-1. City of Tualatin Stormwater Project Opportunities

SW Project Opportunity Area ID	Location	Basin/ Waterbody	Problem/ Project Category	Source	Water Quality (WQ) Retrofit Opportunity	Problem/Project Area Description	Preliminary Project Concepts and Observations (per site visits)	Additional Data Collection/City Input (following Project Development Workshop)	Project Development		
									Project Need	Programmatic Activity	No Project
City wide	Repair and Replacement Program	City wide	• Capacity/ Infrastructure Need • Maintenance/ Condition Assessment	• Staff Questionnaire		• Select storm lines and infrastructure throughout City may need more frequent maintenance to ensure function. • There is no proactive pipe or structure replacement program.	• Development of repair and replacement program for infrastructure (pipes and structures) requiring increased maintenance frequency. Include proactive infrastructure replacement.	• Programmatic activities to be included in Master Plan and rate evaluation. May require multiple programmatic activities.		X	
City wide	Public WQ Facility Maintenance	City wide	• Maintenance/ Condition Assessment • Water Quality	• Staff Questionnaire • WQ retrofit evaluation		• City staff has been receiving complaints from homeowners unaware that a public WQ facility is near their residence. • Re-engineering and/or retrofit of existing WQ facilities may be required.	• Develop a program to review/investigate existing system design and function.	• Programmatic activities to be included in Master Plan and rate evaluation.		X	
City wide	Vegetation Management	City wide	• Water Quality • Maintenance	• Stream Assessment		• Excessive invasive vegetation reported along stream reaches throughout the City.	• Develop a program to remove invasive/replace/restore vegetation along stream channels. • Results of the Stream Assessment (Section 5 and TM3 of the SMP) outline specific observed conditions in reach.	• Programmatic activities to be included in Master Plan and rate evaluation.		X	



City Wide Stormwater Project Opportunities

Program	Category
Repair and Replacement	Capacity/Infrastructure Need
Public Water Quality Facility Maintenance	Maintenance/Condition Assessment
Vegetation Management	Water Quality

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City of Tualatin

Stormwater Master Plan

Date: April 2019
Project: Project 149233

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 3-1

Stormwater Project Opportunity Areas

Section 4

Storm System Capacity Evaluation

Stormwater conveyance is the primary function of the City's stormwater infrastructure. This section outlines the H/H system modeling approach and results for select areas of the city that were used to inform observed capacity limitations and develop project solutions.

System modeling needs were identified as part of the project needs identification effort (Section 3.1.2) and reflect targeted areas of the city requiring hydraulic modeling to analyze existing and future system capacity. Capital project recommendations were developed for each modeled area after verifying capacity limitations and assessing project alternatives. A total of six capital project recommendations stemmed from results of the H/H modeling effort.

The system capacity evaluation is described in additional detail in TM2 and in TM3, included in this SMP as Appendix C and Appendix D, respectively. Model results and figures related to the capital project development are included in this SMP as Appendix E.

4.1 Modeling Approach

H/H modeling was conducted for targeted areas of the city with known capacity limitations and where flooding is frequently observed. This targeted modeling approach was executed to focus resources on specific areas of the city where additional information is needed to quantify system flooding and develop project solutions.

H/H modeling was predominately conducted in the downstream portions of the stormwater collection system that exhibit high flow but are relatively flat. A few areas do not discharge/outfall freely due to high tailwater conditions, resulting in backwater of the conveyance system and flooding. The City does not require detention for new and redevelopment, so as development occurs, there is typically an increase in stormwater flow and runoff volume, and as a result, existing infrastructure capacity may be insufficient to convey the increase in stormwater runoff.

For this SMP, the following modeling approach was used to evaluate stormwater conveyance capacity:

1. Compile a list of known and suspected problem areas and evaluate which areas will require modeling to inform corrective measures (see Section 3.1.2)
2. Review available data (via GIS, as-builts, etc.) to identify data gaps and data required for model development and to inform survey needs
3. Conduct field survey work to supplement data gaps in the City's GIS for the targeted portions of the City's stormwater conveyance system
4. Delineate subbasins and develop a citywide hydrologic model to estimate stormwater runoff generated for existing and future development conditions
5. Develop targeted or system-specific hydraulic models
6. Validate modeled flooding using anecdotal information (photographs, City records)
7. Verify capacity constraints and identify potential sources or causes
8. Use the validated hydraulic models to simulate alternative conveyance system design and develop potential solutions to capacity problems.

4.2 Planning Criteria and Design Standards

Planning criteria related to the analysis of the City's stormwater collection system are documented in the City's Public Works Standards (PW) Standards (2013), the CWS Design and Construction Standards (2007), and the CWS LIDA Handbook (2009).

Planning criteria and design standards are used to identify system capacity limitations and establish the basis of design for water quality and capacity-related projects. A summary of applicable planning criteria and design standards is provided in Table 4-1. Please note that some deviation from established design standards occurs on a case-by-case basis, particularly where slope or pipe cover design constraints exist.

Table 4-1. Drainage Standards and Design Criteria

Criteria	Source	Value
Water Quality Facility Design	PW Standards (206.8)	Design to requirements of CWS Design and Construction Standards and CWS LIDA Handbook. Specific to the PW Standards, facilities are required to have 4' or 6' vinyl coated chain link fencing.
Water Quantity Facility Design	PW Standards (206.8) CWS Design and Construction Standards	Design to requirements of CWS Design and Construction Standards. Match pre- and post-development flow for the 2-, 10-, and 25-yr, 24-hr storm events.
Pipe, Culvert Design Storm[a]	PW Standards (206.3)	Design to the 25-yr storm event. Surcharge during the 25-yr is not permissible. [b]
Open Channel and Ditch Design Storm	PW Standards (206.3)	Design to the 25-yr storm event. Surcharge during the 25-yr is not permissible. [c]
Pipe Size	PW Standards (206.4)	10" minimum diameter for pipe from catch basins to the main in the public ROW. 12" minimum diameter for mains in the public ROW.
Manning's Roughness	PW Standards (Table 206-8)	Varies by material and shape.
Pipe Material	PW Standards (206.4)	Concrete, PVC, ductile iron, and aluminum spiral rib pipe.
Pipe Cover	CWS Design and Construction Standards	Table 5-2, varies by pipe material.
Structure Spacing	PW Standards (206.4)	250' maximum for 10" pipe; 400' maximum for 12" pipe.
Manhole Size	PW Standards (206.6)	48" diameter minimum.

a. *The City's PW standards reference the rational method for conveyance design. Santa Barbara Urban Hydrograph (SBUH) was an approved equivalent as discussed with the City during the July 28, 2016, meeting.*

b. *Per discussion with City staff, surcharge is acceptable for capital project design.*

c. *Due to the consequence of failure (potential road washout), capital project design for culverts used the 100-year peak flow.*

In conjunction with the reissued NPDES permit, CWS is in the process of updating its Design and Construction Standards. CWS released updated standards in April 2017 to address the size of development that requires water quality treatment (impervious area threshold) and the prioritization of LIDA and green infrastructure (GI) facilities to provide treatment. Additional updates were finalized in April 2019 to establish strategies and priorities for addressing effects of hydromodification. These updates have not affected the City's design of capital projects under this SMP.

Additional discussion of stream erosion in accordance with hydromodification risk is provided in Section 5.

4.3 Hydrologic Model Development and Results

A citywide hydrologic model was developed using XP-Storm Water Management Model (XPSWMM) version 2016.1. Within the model, the SBUH method was used to estimate hydrology. The input parameters for the SBUH method include subbasin areas, impervious percentages, pervious curve numbers, and time of concentration. The hydrology routine in XPSWMM converts rainfall into stormwater runoff as a function of the design storm parameters (e.g., volume and intensity of rainfall); subbasin characteristics including topography, land use, vegetation, and soil types.

The hydrology modeling effort, particularly the delineation of subbasin areas, considered locations where the hydrology input is needed for the hydraulic model, such as at system junctions, changes in system slope, or locations where there are changes in conveyance pipe or channel size.

Hydrologic model results are tabulated in TM2 (Appendix C). Results are displayed by subbasin as the maximum flow for each design storm, the change in peak flow, and the percent increase in peak flow between the existing and future development conditions. Overall, the hydrologic model results show minimal to no increases in future flows for subbasins that are fully developed, such as in the Nyberg Creek and Tualatin River (direct) watersheds. The largest increases in flow are in subbasins with larger amounts of vacant land, such as in the Hedges Creek watershed.

4.4 Hydraulic Model Development and Results

There are six Stormwater Project Opportunity Areas where hydraulic models were developed as part of this SMP:

1. Stormwater Project Opportunity Area 1, Martinazzi Avenue at Tualatin-Sherwood Road
2. Stormwater Project Opportunity Area 4, Manhassat Drive
3. Stormwater Project Opportunity Area 5, Boones Ferry Road at Tonka Road
4. Stormwater Project Opportunity Area 7, Herman Road
5. Stormwater Project Opportunity Area 9, Sagert Street at the Shenandoah Apartments
6. Stormwater Project Opportunity Area 10, Mohawk Apartments at Warm Springs Road

Five of the Stormwater Project Opportunity Areas (Nos. 4, 5, 7, 9, and 10) were identified during the project needs identification effort. Additional hydraulic modeling was initiated in July 2018 to evaluate lower Nyberg Creek and the contributing stormwater collection system east of Martinazzi Avenue (Stormwater Project Opportunity Area 1). Modeling efforts focused on capacity and backwater effects of Nyberg Creek on stormwater infrastructure (Lower Nyberg Creek System).

Due to proximity and connectivity of the proposed modeled system, three of the areas (Nos. 5, 9, and 10) were combined into one hydraulic model system (Upper Nyberg Creek System).

Hydraulic model extents, including contributing subbasins, are shown on Figure 4-1 at the end of this section.

4.4.1 Hydraulic Model Development

XPSWMM was used to simulate the hydraulic performance of the select pipe and open-channel systems to calculate peak flows, water surface elevations, and velocities for established design storms. The hydraulic model extents were established upstream and downstream of the identified problem areas to verify the extent and severity of the problem location and develop potential alternatives to correct or mitigate the deficiency.

One-dimensional (1D) XPSWMM hydraulic models were developed based on existing geographic information system (GIS) data provided by the City, field survey collected as part of this master planning effort, and site visits. A two-dimensional (2D) XPSWMM model was developed for the Lower Nyberg Creek System, from Martinazzi Avenue east to Nyberg Lane, based on Light Detection and Ranging (LiDAR), field observations from stream walks, aerial photos, and survey data.

A description of each modeled system is provided below:

- **Manhassat Drive System:** The Manhassat Drive system includes Stormwater Project Opportunity Area 4. The City frequently responds to flooding of the open channel system, starting from Tualatin-Sherwood Road to Manhasset Drive. Based on field reconnaissance, feedback from City staff, and initial system review in GIS, the open channel system is capacity limited. The hydraulic model for the Manhassat Drive system includes the culvert under Tualatin-Sherwood Road and the piped and open channel system running north to the outfall into Hedges Creek.
- **Herman Road System**: The Herman Road system includes Stormwater Project Opportunity Area 7. City staff identified this area during completion of the stormwater surveys as frequently flooding. Based on field reconnaissance, feedback from City staff, and initial system review in GIS, the primary drainage issues include undersized drainage infrastructure and flat grade along Herman Road. The south side of Herman Road does not have a stormwater collection system, which results in standing water on the roadway. The hydraulic model for the Herman Road system includes the piped and open channel conveyance along Herman Road between Southwest Teton Avenue and Southwest Tualatin Road, as well as the open channel/piped system between Herman Road and the outfall at Sweek Pond.
- **Upper Nyberg Creek System:** The Upper Nyberg Creek system includes Stormwater Project Opportunity Areas 5, 9, and 10. All three areas were identified due to frequent flooding and the need for further assessment. Collectively, transport of sediment and gravel in this system, combined with the relatively flat grade of the system, results in reduced capacity of the stormwater collection system and backwater and flooding effects. The hydraulic model is extensive and includes the open channel system along the railroad tracks west of Boones Ferry Road, the piped drainage system on Boones Ferry Road, the culverts discharging east under Boones Ferry Road, the open channel system flowing east from Boones Ferry Road to Martinazzi Avenue, and the open channel and piped systems discharging north to Nyberg Creek from Seminole Trail Warms Springs Street.
- **Lower Nyberg Creek System:** The Lower Nyberg Creek system includes Stormwater Project Opportunity Area 1 and extends along Nyberg Creek from Martinazzi Avenue to Nyberg Lane. Both 1D and 2D modeling approaches were used to evaluate flooding extents, potential causes of flooding and comprehensively assess how modifications to Nyberg Creek influences upstream stormwater system The Upper Nyberg Creek model 1D model was extended to include the Nyberg Creek channel from Martinazzi Avenue to the culvert outfall at Nyberg Lane and portions of the stormwater collection system along Tualatin-Sherwood Road and Martinazzi Avenue. The 1D and 2D models are linked in XPSWMM and simulated as a single model of the channel and floodplain.

For the Manhassat, Herman Road, and Upper Nyberg Creek System, existing condition hydrology for the 25-year storm event was used to initially evaluate the capacity of the modeled systems and validate model results. Model results were compared to anecdotal flooding reports and City photographs taken during the December 2015 storm event (for the Manhasset Drive system). Model validation information did not include specific flows or water surface elevations at structures within each of the hydraulic model areas. Therefore, model refinements instead of a model calibration were performed by adjusting hydraulic input parameters based on field observations to match reported flooding.

No recent model validation or calibration data were available for the Lower Nyberg Creek System.

Both existing and future condition hydrology were applied to the validated hydraulic model. This process enables the existing infrastructure to be assessed for future capacity needs.

4.4.2 Capacity Evaluation Results

The hydraulic model results showed minimal to no increases in future flows for the modeled areas that are fully developed. As expected, the largest projected flow increases were seen in areas with existing vacant lands. The hydraulic model results confirmed the flooding problem areas/capacity-limited areas as reported by City staff and provided additional information about potential sources of the problems.

Detailed hydraulic modeling results (tables and figures) are provided in Appendix C for the Manhassat, Herman Road, and Upper Nyberg Creek System. Hydraulic modeling results are provided for the Lower Nyberg Creek System in Appendix D.

A summary of the hydraulic modelling results by modeled system is provided below. Table 4-2 summarizes the general modeled flooding locations, the potential source of the capacity deficiencies, and whether a capital project was developed to address the flooding.

- **Manhasset Drive System:** The hydraulic model shows extensive flooding during the 2-year design storm in the stormwater system along Manhasset Drive, especially along the open channel portion where the open channel cross sections are non-symmetrical and limited in capacity. Proper open channel maintenance, including debris removal and regular mowing of channel vegetation, may alleviate some flooding; however, the channel is still undersized for the contributing flow. Because pipes further downstream (north of Manhassat Drive) experience surcharging they do not meet City design standards; however, the maximum water elevations are not above manhole rim elevations.
- **Herman Road System**: The hydraulic model shows extensive flooding in the open channel/culvert system along Herman Road between SW Teton Avenue and SW Tualatin Road. The open channel system north of Herman Road is further restricted by the two culverts across Herman Road. These culverts have a non-traditional layout, likely due to the ground clearance required beneath the railroad and have a negative or backslope. To the east, the parallel culverts south of the intersection of Tualatin Road and Herman Road begin surcharging at the 2-year event. Figures 4-3 and 4-4 show the extent of modeled flooding by conduit.
- **Upper Nyberg Creek System:** The hydraulic model shows widespread system flooding during the 2-year and 10-year design storms. One prevalent location of flooding is the open channel system along the railroad tracks west of Boones Ferry Road (19417 SW Boones Ferry Road). The open channel is overtopping, and the downstream pipes are surcharging, resulting in flooding of nearby businesses. Flow bypassing the system is discharging to Boones Ferry Road via overland flow, consistent with the flow patterns reported by city staff. Sediment accumulation further restricts conveyance across the parallel culverts at Boones Ferry Road.

  Additional area experiencing surcharge and flooding is the pipes north of Seminole Trail between Tillamook Court and Martinazzi Avenue, starting at the 10-year event. Modeling did not indicate flooding of the open channel system, but because any system upsize would impact the open channel, capital project development must include a comprehensive review of project needs in this area. Finally, the pipes near the intersection of SW Boones Ferry Road and SW Warm Springs Street and the intersection of SW Warm Springs Street and SW Tonka Street are surcharging beginning at the 10-year event.

- **Lower Nyberg Creek System:** The hydraulic model shows systemic flooding along Martinazzi Avenue and Tualatin-Sherwood Road. The flooding is due to the low elevation of roadways and parking lots, low gradient conveyance systems and the low gradient in the Nyberg Creek itself.

  As described in TM3 (Appendix D), larger regional events result in widespread flooding along Martinazzi Avenue from Nyberg Creek to Tualatin-Sherwood Road due to the backwater effects of the Tualatin River on Nyberg Creek. More frequent, nuisance flooding (evaluated based on a 5-year, 24-hour design storm) still occurs along Martinazzi Avenue and Tualatin-Sherwood Road, but is the result of limited capacity of the collection system to convey flow as opposed to backwater conditions.

Table 4-2. Capacity Evaluation Result Summary and Capital Project Development Approach

Modeled System	General Location	Conduit	Surcharging/ Flooding Scenario	Source of Capacity Deficiency	Capital Project Development (Y/N) [a]
Herman Road System	Open channel/culvert system on north side of Herman Road	Link32.1	Existing 10-yr	Existing culverts are undersized and have minimal slope. Multiple transitions from open channel to a piped system lead to high energy losses.	Y – CIP 8
		Link34.1	Existing 10-yr		
		322603	Existing 2-yr		
		322638.1	Existing 2-yr		
		333704.1	Existing 2-yr		
		333705.1	Existing 2-yr		
		333706.1	Existing 2-yr		
		333707.1	Existing 2-yr		
		334080.1	Existing 2-yr		
		Link33.1	Future 2-yr		
	Culvert across Herman Road	322643	Existing 2-yr	Culvert has minimal slope and nearby pipes show unusual change in inverts. Culvert is surcharging but not flooding. Follow up survey with detailed design recommended.	N
	Dual culvert south of intersection of Tualatin Road and Herman Road	322618	Existing 2-yr	Culvert has minimal slope. Culvert is surcharging but not flooding.	N
	Stormwater system at intersection of Tualatin Road and Herman Road	268371	Future 25-yr	Pipes is surcharging but not flooding. Refined hydrology during project design may refine project need.	N
Manhasset Drive System	Open channel along Manhasset Drive	Link9	Existing 2-yr	Open channel is undersized and not properly maintained.	Y – CIP 1
		Link10.1	Existing 2-yr		
		Link11.1	Existing 2-yr		
		Link12.1	Existing 2-yr		
		Link13.1	Existing 2-yr		
		Link14.1	Existing 2-yr		
	Piped system downstream of open channel on Manhasset Drive	266695	Existing 2-yr	Existing pipes are surcharging but not flooding due to minimal slope.	Y – CIP 1
		266697	Existing 2-yr		
		268265	Existing 2-yr		
Lower Nyberg Creek System	Piped system along Martinazzi Avenue and Tualatin-Sherwood Road	Link91	Existing 5-yr[b]	Nyberg Creek is surcharged to the outfall at Martinazzi Avenue. Backwater conditions result in system surcharging and localized flooding.	N
		Link102			
		Link103			
		Link93.1			
		Link100			

Table 4-2. Capacity Evaluation Result Summary and Capital Project Development Approach					
Modeled System	General Location	Conduit	Surcharging/ Flooding Scenario	Source of Capacity Deficiency	Capital Project Development (Y/N) [a]
		Link99			
		Link98			
		Link94			
		Link 136			
		Link74			
		267573_1			
		267573_2			
		267573_3			
		Link97			
		Link134			
		Link135			
		Link86			
		Link89			
Upper Nyberg Creek System	Open channel and pipe system behind Oil Can Henry's including junction of outfalls directly west of Boones Ferry Road	Link36	Existing 2-yr	Rock/gravel accumulation is limiting capacity. Project needs may include source control and maintenance.	Y – CIP 7
		Link43.1	Existing 2-yr		
		Link80	Existing 2-yr		
		277225	Future 2-yr		
	Piped system on Boones Ferry Road near Warm Springs Street	268293	Existing 10-yr	Existing open channels and pipes are undersized for the contributing drainage area. This system receives overland flow from the open channel behind Oil Can Henrys. System rerouting may help alleviate flooding.	Y – CIP2, Phase 3
		322832	Existing 10-yr		
		268296.1	Existing 25-yr		
		267215	Future 10-yr		
		268297.1	Future 25-yr		
	Piped system at intersection of Warm Springs Street and Tonka Street	264286	Existing 10-yr	Existing pipes have minimal slope and are undersized. System rerouting may alleviate flooding.	Y – CIP 2, Phase 2
		265109	Existing 2-yr		
	Piped system between Seminole Trail and Sagert Street	267910	Existing 10-yr	Existing pipes are undersized for contributing drainage area. Pipes are surcharged but not flooding. System is upstream of reported Sandalwood project opportunity area.	N
		267951	Existing 10-yr		
		264521	Future 10-yr		
	Sandalwood open channel	Link31	-	No flooding in model; however, flooding was reported during the December 2015 storm event. Channel is incised.	Y – CIP 3
	Open channel behind Mohawk Apartments	Link32	-	Open channel is not flooding in the model; however, flow is being restricted at the downstream ditch inlet, which has large hydraulic losses.	Y – CIP 4 and CIP 2, Phase 1
		Link 33	-		

a. Capital projects are detailed in Section 7. Capacity deficiencies associated with system surcharging were not prioritized for project development (see Section 7.3).

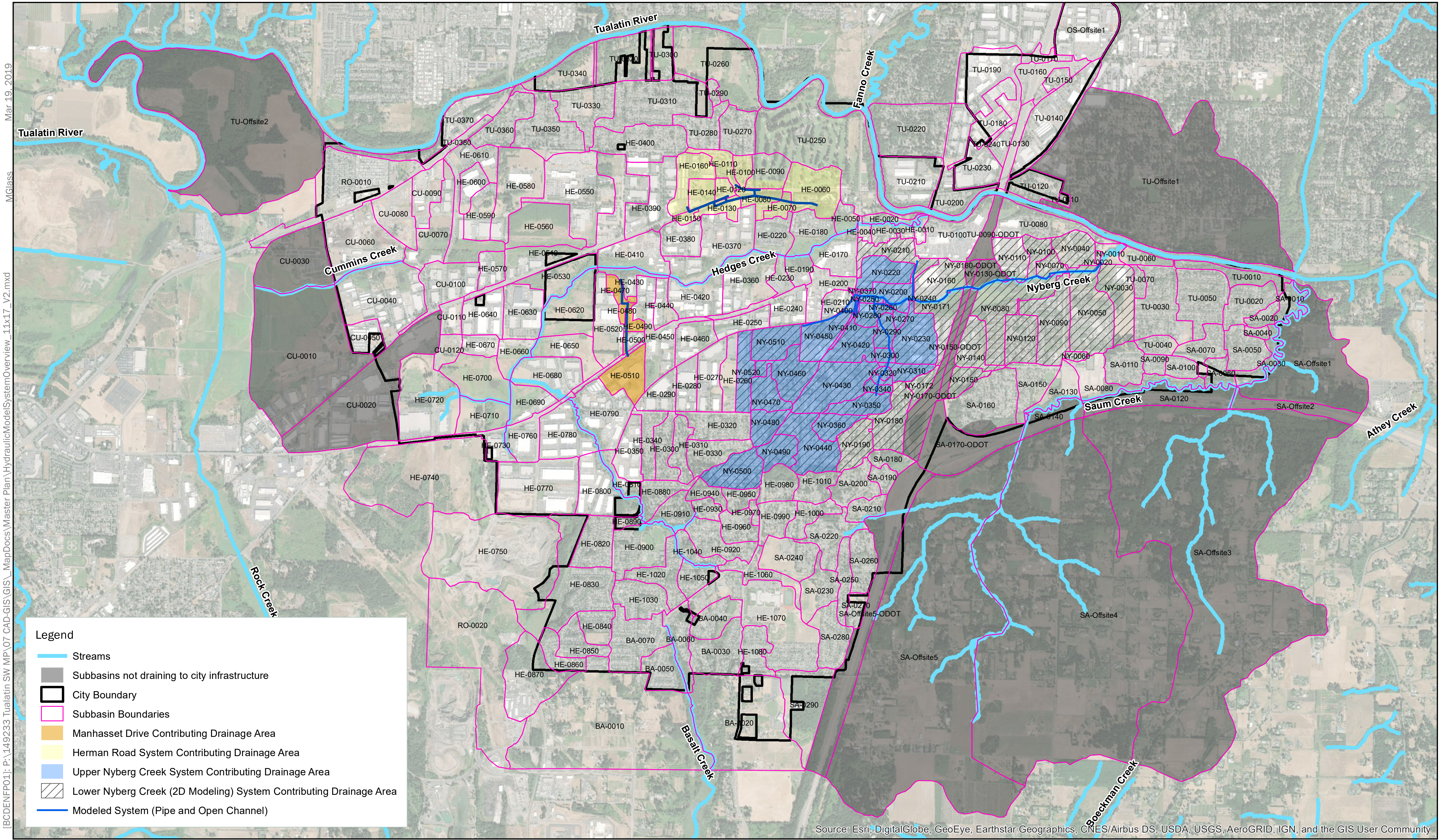
b. The 5-year design storm was evaluated for this reach to reflect nuisance flooding. Significant instream channel modifications (widening or regrading) is needed to alleviate flooding.

4.5 Capital Project Development

Based on the system capacity analysis, project alternatives were identified and evaluated to address modeled capacity issues. For some locations, multiple system configurations and sizing were tested to develop the preferred conceptual solution. Project alternatives were discussed with the City during the project development workshop (Section 3.2).

The preferred system configuration was developed into a capital project concept and a preliminary cost established based on the improvements required. For the Manhassat and Herman Road systems, one capital project was developed to address each system deficiency. Because the Upper Nyberg Creek System covered a large area and multiple stormwater project opportunities, a total of five capital projects were developed. Capital project fact sheets that included a project description, project considerations, and preliminary costs are included in Appendix A.

- Manhassat Storm System Improvements (CIP 1). This project addresses flooding due to an undersized conveyance channel and pipe system. This location is associated with Stormwater Project Opportunity Area 4.
- Nyberg Creek Stormwater Improvements (CIP 2). This project addresses undersized pipe pipes and ongoing maintenance issues along Boones Ferry Road, Warm Springs Street, and Martinazzi Avenue. This large project is split into three phases. This location is associated with Stormwater Project Opportunity Area 5.
- Sandalwood Water Quality Retrofit (CIP 3). This project addresses erosion and capacity concerns related to an open channel conveyance system. Water quality features are also incorporated. This location is associated with Stormwater Project Opportunity Area 9.
- Mohawk Apartment Stormwater Improvements (CIP 4). This project addresses limited capacity and system condition concerns and helps eliminate downstream flooding. This location is associated with Stormwater Project Opportunity Area 10.
- Herman Road Storm System (CIP 5). This project adds infrastructure to address frequent flooding. This location is associated with Stormwater Project Opportunity Area 7.
- Boones Ferry Railroad Conveyance Improvements (CIP 7). This project addresses ongoing maintenance issues, flooding, and backwater conditions along railroad ROW. This location is associated with Stormwater Project Opportunity Area 5.



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City of Tualatin

City of Tualatin

Stormwater Master Plan

Date: April 2019
Project: Project 149233

0 2,250 4,500 Feet

N

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 4-1

Model System Overview

Section 5

Stream Assessment

Tributary stream channels to the Tualatin and Willamette rivers are an important element of the overall stormwater collection and conveyance system in the city. Stream channels provide conveyance and storage of water and sediment and provide habitat for aquatic and terrestrial species.

This section outlines results of the stream assessment conducted for select stream reaches in the city to inform project, program, and policy recommendations. Stream assessment needs were identified as part of the project needs identification effort (Section 3.1.3), to evaluate stream reaches observed to have erosion, invasive vegetation and hillslope instability. The stream assessment is described in additional detail in TM4, included in this SMP as Appendix F.

A total of three capital project recommendations stemmed from results of the stream assessment effort. Program and policy recommendations were also proposed to protect and proactively benefit the stream system.

5.1 Stream System Overview

The City of Tualatin's geography and topography are unique. While the city is located adjacent to the Tualatin River, much of the city drains to smaller tributary streams, including Nyberg Creek, Saum Creek and Hedges Creek. The City is in the downstream, lower portion of the Tualatin River watershed, approximately five miles from its confluence with the Willamette River. As such, topography is relatively flat and tributary stream channels have low gradient and are relatively well connected to the surrounding floodplain. There are extensive wetlands that compose much of the Hedges Creek and Nyberg Creek stream corridors.

Below is a brief description of Tualatin River and five tributary stream channels in the city, including ownership characteristics and description of the associated drainage basins:

- The Tualatin River is located along the northwestern border of the City. Relatively limited city area directly discharges to it, and the contributing drainage area is composed of low-density residential and open space. Backwater conditions from the Tualatin River routinely affect stormwater drainage for property near the river, resulting in standing water and flooding on parking lots and roadways.
- Cummins Creek is in the northwest part of the city and is a tributary to Rock Creek and the Tualatin River. The contributing drainage is predominately industrial with some open space (wetland) areas. Cummins Creek is considered privately owned.
- Hedges Creek drains the majority (44 percent) of the city area, and its watershed is almost exclusively located in the city. Much of the waterbody is considered privately owned, including large areas owned by the Wetlands Conservancy. Contributing land use is predominately industrial and low-density residential. Hedges Creek is considered highly modified due to extensive, historic development activities with limited stormwater management that occurred in the watershed.

- Nyberg Creek crosses I-5 and is the primary receiving water for much of the commercial development areas along I-5 and Tualatin-Sherwood Road. Contributing land use is commercial, industrial and low-density residential. Nyberg Creek has extensive wetland complexes and on-going beaver activity. Like Hedges Creek, ownership is a combination of private (Wetlands Conservancy) and public (City and the Oregon Department of Transportation).
- Saum Creek is in the southeastern portion of the City. Contributing land use is low-density residential and open space. There are significant greenways and natural areas along the lower (downstream) portion of the stream channel, which helps limit encroachment and direct impacts to the channel resulting from development. Ownership is a combination of private and public (City).
- Basalt Creek runs north-south in the southern portion of the City. Much of the contributing land use is low-density and rural residential, but with pending adoption of the Basalt Creek Concept Plan concept plan, future development is anticipated to impact the contributing land use and stream condition. Ownership is currently private and public (City).

5.2 Objectives

The stream assessment focused on direct observations gained from conducting stream walks along priority reaches of Saum, Nyberg, and Hedges creeks. Objectives 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
- Recommend capital, operational, maintenance or other solutions for issues identified

Objectives of the stream assessment were developed to support continued evaluation of stream channel conditions in the city. Information collected as part of this assessment should be referenced and used during future inspection efforts to help assess improvements and degradation.

5.3 Methodology

City staff identified nine priority reaches in the city based on ownership, history of staff or citizen complaints/concerns, and potential for additional stream flow due to new or redevelopment activities. Figure 5-1 at the end of this section identifies specific stream reaches investigated.

Stream walks were conducted between September 11, 2017, and September 15, 2017. A total of 10 reaches were evaluated, including all nine priority reaches plus Hedges Creek Reach 3A, an optional reach associated with Stormwater Project Opportunity Area 8 (see Table 3-1). A total of 23,225 linear feet of stream and riparian corridor was evaluated.

During the stream walks, photographs were taken to document stream characteristics and condition. Physical and biological stream conditions were noted and mapped and included:

- 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 the stream channel
- Wildlife activity (presence of beaver dams)

Photo logs and stream reach summary sheets were developed to identify cross section and physical condition characteristics for each reach at the time of the stream walk.

5.4 Findings and Results

Observations made during the stream walks were used to qualitatively identify current stream channel deficiencies and potential strategies for improvement. A detailed summary of stream channel condition by reach is provided in Appendix F. General reach characteristics are provided in Table 5-1.

Table 5-1. Summary of Stream Reach Conditions

Stream	Reach	Length (ft)	Average Gradient (%)	Average Valley Width (ft)	Contributing City Drainage Area (ac)	Contributing Existing Impervious (%)	Contributing Future Impervious (%)	Difference (%)
Saum	1	6,775	0.6	100-200	493	34	42	8
	2	4,950	0.4	150-175	460	37	44	7
	3	600	1.1 (upstream) 3.0 (downstream)	75-100	367	37	44	7
Nyberg	1	950	<0.1	300-400	816	46	57	11
	2	2,100	0.1	500-650	607	41	57	16
	3	1,400	0.3	30-60	399	36	57	21
Hedges	1	2,250	0.8	75 - 125	2,340	48	58	10
	2	1,900	0.2	125-250	754	41	51	10
	3A	1,740	<0.1	~150	608	36	47	11
	3B	560	3.7	~50	138	40	50	10

5.4.1 Vegetation

Stream reaches were found to contain significant amounts of invasive, non-native vegetation such as reed canary grass, Himalayan blackberry, jewel weed, and English Ivy within their riparian corridor. Invasive vegetation was observed in almost every investigated stream reach, although some reaches were heavily impacted. Invasive vegetation can limit native vegetation growth and constrain flow capacity and beneficial habitat. Evidence of beaver activity was prevalent as well.

Reaches did show a distinct lack of trash in and around the channel, which is positive and noteworthy given its urban/suburban setting.

5.4.2 Riparian Condition

Wide riparian corridors surround many of the stream channels. Preservation of wide riparian corridors and connection to floodplain is important, especially for low-gradient streams like those in the City because these reaches require space to maintain meandering characteristics and a stable channel form. This finding is positive and noteworthy given the urban/suburban setting.

The upstream/headwater stream reaches investigated were generally steeper and had more confined channels. There is very little in-channel or floodplain storage capacity in these areas to dissipate flows. Riparian vegetation in these areas is also limited. Riparian vegetation provides channel stability and slope stability through water interception, water uptake, and soil reinforcement from roots. A limited riparian buffer combined with a steeper gradient makes these stream channels more susceptible to channel stability issues (see Section 5.4.3).

5.4.3 Channel Erosion and Incision

Stormwater runoff, particularly in urban areas, has the potential to impact stream conditions. Increases in impervious areas through development and redevelopment can alter runoff conditions and increase the timing and magnitude of flows to stream channels. Increased flow can alter stream channel conditions and result in flooding, bank erosion, bed incision, sediment production, and other impacts, commonly referred to as hydromodification. Physical stream channel conditions (i.e., riparian width, stream channel gradient, and channel confinement from development or topographic conditions) were documented and considered in conjunction with observed bank and bed erosion.

Instances of bed and bank erosion were most prevalent in the headwater stream reaches evaluated (e.g., Hedges Creek Reach Nos. 3A and 3B), which are exposed to the first effects of high flows conveyed from surrounding residential neighborhoods during rain events.

The future potential for bed and bank erosion can be observed in conjunction with the potential for development (and associated increases in impervious surface area) (Table 5-1). Upstream reaches, specifically in Nyberg Creek and Hedges Creek, are relatively narrow and show a greater potential for increases in runoff from impervious surface areas. Policies related to flow control may be warranted for select stream reaches to mitigate impacts of increased stormwater runoff.

5.5 Additional Investigations

Independent from the stream assessment conducted for this SMP, the City's Parks Department conducted a supplemental assessment of Hedges Creek from SW Ibach Street to SW 105th Avenue (Hedges Creek Stream Assessment, February 2018). Hedges Creek Reach Nos. 3A and 3B are included in this evaluation effort. In addition, this supplemental assessment extended west along the southern Hedges Creek tributary, adjacent to SW Ibach Street.

Potential project needs were identified and prioritized along Hedges Creek. Findings from this supplemental assessment generally corresponded with findings from the stream assessment where locations overlapped.

City staff reviewed the findings and qualified the identified stormwater project needs from this supplemental assessment, and selected project needs to include as part of this SMP.

5.6 Capital Project and Program Development

Findings from the stream assessment and supplemental Hedges Creek Stream Assessment were used to identify stormwater project and program needs. Identification of stormwater project needs was isolated to reaches under City ownership.

In addition, the City may consider policies to mitigate stormwater flow associated with new and redevelopment, particularly in headwater stream reaches with observed erosion and downcutting. The City may also consider beaver management efforts to maintain in-channel conveyance capacity and address localized flooding issues resulting from beaver activity.

5.6.1 Capital Project Needs

Three capital project needs were verified in conjunction with the stream assessment. Two locations were originally identified during preliminary stormwater project planning (Section 3.0) as Stormwater Project Opportunity Areas. Capital project fact sheets that include a project description, project considerations, and preliminary costs are included in Appendix A.

- **Blake Street Culvert Replacement (CIP 6).** This project addresses an undersized culvert and failing headwall along Hedges Creek. The stream assessment identified headwall deterioration and bank erosion due to the culvert's orientation. This location is associated with Stormwater Project Opportunity Area 8 and was also identified as a project need in the supplemental Hedges Creek Stream Assessment.
- **Saum Creek Hillslope Repair (CIP 19).** This project replaces a degraded outfall pipe and repairs the hillslope failure near the outfall. The stream assessment confirmed the perched outfall location and evaluated stream bank conditions immediately upstream and downstream of the outfall. This location is associated with Stormwater Project Opportunity Area 3.
- **Hedges Creek Stream Repair (CIP 20).** This project includes an outfall extension, bioengineered slopes, streambed fill, vegetation restoration and construction of a retaining wall to address observed instream channel erosion and protect infrastructure. This location was identified as a project need in the supplemental Hedges Creek Stream Assessment.

5.6.2 Program Needs

Results from the collective stream assessment efforts and preliminary project planning (Section 3.0) support the need for an annual program to conduct vegetation management along stream corridors. Efforts would be targeted at: 1) invasive vegetation removal, 2) planting and irrigation (as necessary) 3) installation of native riparian plants, and 4) ongoing inspections to refine future maintenance needs and compare overall stream channel conditions against results from this baseline evaluation.

Results from the stream assessment efforts prioritized the following reaches for vegetation management activities (Table 5-2). Cost assumptions related to the program efforts are detailed in Section 7.

Table 5-2. Priority Locations for Vegetation Management

Stream	Reach	Approximate Length (ft)	Location Description	Invasive Vegetation	Ownership
Saum	3	200	Upstream of SW Blake Street near a recent restoration project	Reed canary grass, Himalayan Blackberry	City
Nyberg	3	1,400	Entire reach	Reed canary grass	City (approximately 300' private)
Hedges	1	500	Tualatin Community Park	Reed canary grass	City
	2	1,900	Entire reach	Reed canary grass, Himalayan Blackberry	City
	Southern Tributary	200	Locations C, D, and F identified in the supplemental Hedges Creek Stream Assessment	Not specified	City

5.6.3 Policy Considerations

The following policy considerations may be incorporated into future updates to the Tualatin Public Works Construction Code, Tualatin Municipal Code (Title 03), or addressed through internal directives.

5.6.3.1 Detention/Flow Control Stormwater Design Standard

In April 2019, CWS adopted updated Design and Construction Standards with updated language in Chapter 4: Runoff Treatment and Control[2]. Updated language incorporates new design requirements related to water quantity and hydromodification control and builds on previous efforts from 2017 (see Section 3.2). New and redevelopment greater than 12,000 square feet of impervious surface will be required to conduct a Hydromodification Assessment and implement strategies commensurate with the receiving water Hydromodification Risk Level, Development Class, and Project Size.

Results from this stream assessment effort and additional investigations conducted by the City appear consistent CWS's published Hydromodification Risk Levels for receiving waters, which identify upper Hedges Creek and Saum Creek as moderate or high risk for hydromodification.

The City currently implements CWS's Design and Construction Standards for water quality. The City should consider adopting the updated CWS Design and Construction Standards, including standards that address water quantity control and hydromodification, in accordance with areas identified as experiencing channel erosion and incision.

5.6.3.2 Beaver Management Activities

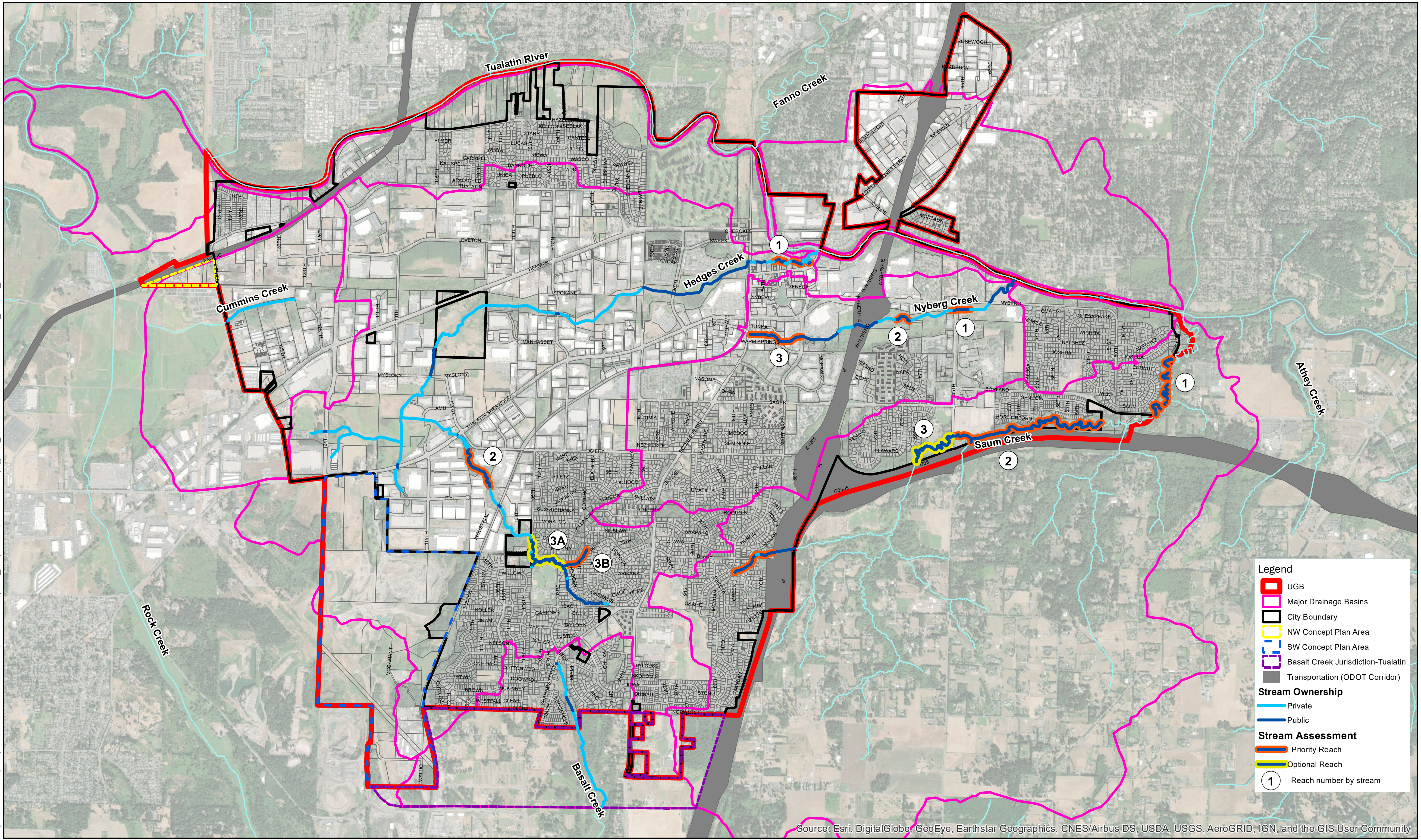
The stream assessment effort identified significant beaver activity along investigated reaches. Beavers provide many benefits to stream ecology and habitat, but in urban areas, beaver activity can result in localized flooding and backwater effects in stream channels.

Beavers are classified as "Protected Furbearers" in Oregon, and thus excluded from take (Oregon Administrative Rule 498.012) (Portland 2010). The ODFW encourages public and private landowners to first use beaver exclusion and habitat modification techniques to minimize beaver activity in locations that are susceptible to impacts from beaver activity.

The City may choose to implement/codify beaver management techniques to selectively encourage/discourage beaver activity based on the characteristics of their stormwater drainage systems, topography and vegetation. Management techniques for consideration include:

- **Selective planting:** Encourage/discourage beaver activity through planting of preferred plant species. To minimize or deter beaver activity, avoid use of alder, birch, cottonwood, willow, and other preferred deciduous plants in riparian restoration projects and use non-desirable plant species, including Sitka spruce, elderberry, cascara, and osoberry, as they are not preferred food plants for beavers.
- **Fencing/tree barriers:** Install fencing to isolate one or groups of trees from beaver foraging. Fencing should be 2 to 4 feet high. Install fencing around inlets of culverts or spillways to prevent beavers from blocking inlets.
- **Tree painting:** Paint the bottom (2 feet to 4 feet) of trunk with latex paint/sand mixture.
- **Flood/Flow Control:** Install a flexible pond leveler (a pipe through the beaver dam) to control water levels. Beaver dam removal can also be conducted to lower water levels, but this activity is time intensive and generally only a temporary solution.

[2] On November 12, 2019, CWS Board of Directors adopted the most recent amendments to the CWS' Design and Construction Standards. Such amendments included updates to standard engineering details, pump station standards, and minor changes to text for clarity. Implementation policies referenced in this Plan for development projects were adopted in April 2019 and remain in effect.



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City of Tualatin

City of Tualatin

Stormwater Master Plan

Date: April 2019

Project: Project 149233

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0 2,250 4,500 Feet

Notes:

1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 5-1

Stream Assessment Overview

Section 6

System Maintenance and Programmatic Assessment

This SMP includes projects and programs intended to support the City's long-term asset management efforts and supplement existing maintenance activities.

This section outlines maintenance-related project and program needs stemming from review of the City's current maintenance activities and costs, site visits, and staff feedback during a programmatic activity workshop. Project needs are considered a one-time planning and cost effort, whereas program activities are continuous and require annual funding. A detailed condition assessment of City infrastructure was not performed as part of this SMP, but activities to protect and preserve existing assets are proposed, based on the condition of the City's stormwater collection, conveyance, and treatment systems.

A total of six capital project recommendations are associated with condition or maintenance-related deficiencies. Additionally, four program strategies are proposed to maintain City infrastructure and/or provide ongoing water quality benefits.

6.1 Maintenance Overview

Maintenance is a necessary requirement for the long-term health and stability of the City's stormwater program. This includes the maintenance of piped conveyance systems, open-channel conveyance system, stormwater structures (manholes, catch basins, etc.), water quality facilities, outfalls and natural systems, and other elements of the stormwater system. Neglected systems perform at a lower level than maintained systems, and it is typically more expensive to fix a neglected system than to conduct preventive maintenance. Maintenance is recommended to be a priority for all elements of the City's stormwater system.

The City contracts out and internally conducts scheduled (routine) and unscheduled maintenance activities on stormwater infrastructure and facilities throughout the City. Many maintenance activities and frequencies are specified in conjunction with CWS's watershed-based NPDES permit. As a co-implementor of the NPDES permit, the City conducts and reports on maintenance activities annually for permit compliance.

Table 6-1 provides an overview of the City's current maintenance activities and obligations, along with an average estimate of staff time to perform the maintenance activity. Based on current NPDES annual reporting, the City can meet most maintenance targets, but public water quality facility maintenance is one area of needed improvement.

Table 6-1. City Maintenance Activities					
Activity	Frequency required	Annual Target [a]	Annual Effort [a]	Meeting target? (Y/N)	Staff/Division
TV inspection	8-year cycle	57,000 ft	57,000 ft	Y	Storm Division or contract
Pipeline cleaning	6-year cycle	75,000 ft	75,000+ ft	Varies	Storm Division
Ditch inspection/cleaning	--	--	--	--	Storm Division
CB cleaning (with sumps)	Annual	1,200	1,200	Y	Storm Division
CB cleaning (without sumps)	Annual	1,600	1,600	Y	Storm Division
Water quality MH cleaning	2x/year	126 (based on 63 MH)	140+	Y	Storm Division
MH cleaning	----	-----	-----	--	Storm Division
Street sweeping	12x/year	150 curb miles	150+ mi	Y	Storm Division or contract
Public water quality facility inspections [b]	4x/year	1,200 (based on 300 facilities)	1,200+	Y	Engineering
Public WQ facility maintenance	As needed	----	----	N	Contracted via Parks or Storm Division
Private WQ facility inspections[b]	25%/year	68	80+	Y (need for improved system tracking)	Engineering

a. Values provided are approximate based on the asset inventory documented per the CWS NPDES 2015-16 annual report.

b. Updated per email from Shawn Strasser 10/6/17.

6.2 Programmatic Activity Workshop

On April 19, 2018, City and BC staff met to review the City's existing stormwater maintenance-related efforts and discuss general stormwater program needs. Discussion included the City's current funding allocations for maintenance-related activities. A summary document was distributed to staff summarizing the City's asset inventory (from GIS) and maintenance obligations as detailed in CWS's effective SWMP. The goal of the workshop was to define additional programmatic efforts to include in this SMP, along with a dedicated annual funding commitment, to improve upon the City's current programs to protect and preserve assets.

Stormwater project needs identification (Section 3.1) efforts resulted in the identification of three citywide maintenance-related program needs, which formed the basis for discussion of programmatic activities. These citywide needs included:

- Repair and replacement program
- Public water quality facility maintenance program
- Vegetation management program

Current, dedicated funds to support maintenance related activities are limited and do not include a reserve to support variable system maintenance or replacement needs. Relevant program cost information based on the City's 2018-2019 budget is listed in Table 6-2 below.

Table 6-2. Existing Program Funding (2018-19)		
Relevant Activity	Annual Budget	Staff/Division
Repair of Stormlines/MH/CBs	$19,400	Storm Division
Line Repairs to System	$25,000	Storm Division
CCTV Inspection	$53,530	Storm Division or contract
Retrofit CBs (CWS requirement)	$45,500 [a]	Storm Division
Contract Landscape Services at 72 sites (reflects water quality facilities but also general landscaping needs)	$108,300 [b]	Contracted via Parks or Storm Division

a. For 2018-19, the annual $45,500 was doubled to account for unspent funds in 2017-18.

b. Assume $25,000 of annual budget is reserved for facility maintenance.

Program activities are defined and described below with respect to conveyance system condition deficiencies, and public/private water quality facilities. Program needs related to vegetation management were previously defined in conjunction with the stream assessment results (see Section 5.6.2).

6.2.1 Conveyance System Condition Deficiencies

A stormwater system condition assessment requires review of available, current stormwater system information to identify areas of failure, pending or imminent failure, and areas that are rapidly deteriorating.

Much of the City's infrastructure was constructed in the last 30 years in conjunction with private development trends. As such, the City's stormwater infrastructure (pipe and structures) should have several decades of service life remaining; however, pipe age is not currently tracked in the City's GIS. CCTV of the City's stormwater infrastructure is conducted to address NPDES permit requirements, but detailed evaluation of the CCTV results has not occurred. A condition assessment of buried stormwater infrastructure to confirm remaining service life has also not been conducted to date.

As part of this SMP effort, the City is looking to identify pipe and structure replacement needs and plan for long-term asset replacement, repair, and rehabilitation. Development of a repair and replacement (R/R) program is a critical component of this effort. An R/R program begins by establishing baseline condition data to track and address pipe and structure condition moving forward.

The City wishes to establish separate programs (and annual funding mechanisms) for R/R to address pipes and structures. These programs should first assess and track infrastructure health in conjunction with current CCTV inspections to establish a baseline condition assessment. Pipe and structure R/R can follow as needed. These programs are described further in Section 6.3.2.

6.2.2 Public/Private Water Quality Facility Inspection and Maintenance

In accordance with requirements of the CWS NPDES permit, there is increased emphasis on methods for improving stormwater quality. One method is through the tracking, inspection, and maintenance of existing public and private stormwater treatment facilities to ensure that function of these facilities is preserved.

Development of this SMP included a detailed look at existing public water quality facility conditions. The project needs assessment (Section 3.0) identified five project opportunities where the function of the stormwater treatment facilities was compromised. Based on site inspections, these locations require facility restoration as opposed to just maintenance. Restoration efforts include vegetation management and removal (including trees), sediment removal and regrading, installation of amended soil to support plant growth, and rehab/replacement of inlet or outlet structures. These restoration needs are addressed with capital projects, as detailed in Section 6.3.1.

Preliminary project planning efforts also identified that ongoing (routine) public water quality facility maintenance does not regularly occur. Maintenance is conducted on an as-needed basis as time and funding allow. The City contracts out most of the stormwater facility maintenance activities, which can result in delays. The City regularly inspects facilities in accordance with efforts documented in Table 6-1. Recent inspection efforts identified the following priority locations that require maintenance to ensure functionality, although a stand-alone capital project need was not identified at this time:

- **Lakeridge Terrace Facility Maintenance.** Facility (pond) was constructed in 2001 to serve a 48-lot subdivision. Maintenance needs include sediment removal (facility and outlet structure), tree removal, and replanting.
- **Gertz Swale Redesign.** Facility was constructed in 2003. Stormwater currently short-circuits the facility and results in erosion. Maintenance needs include re-grading the facility, vector management, and installation of an impermeable membrane.
- **Shasta Trail Swale Maintenance.** Facility was constructed in 2004. Stormwater currently short-circuits the facility and results in erosion and discharge to neighboring property. Maintenance needs include re-grading the facility, vector management, and installation of an impermeable membrane.
- **Green Lot Swale Maintenance.** Facility was constructed in 2005. Maintenance needs include re-grading the facility, sediment removal, and vegetation management (removal and replanting)

Figure 6-1. Example of buried outlet control structure at the Green Lot Swale

(photo courtesy of City of Tualatin)

As part of this SMP effort, the City identified the need for a program (and annual funding mechanism) for continual public water quality facility maintenance. The program can be used to conduct both routine maintenance activities and support larger system restoration or redesign needs. Efforts should prioritize facilities identified through annual inspection efforts, including those priority locations listed above.

In addition, in conjunction with CWS's updated Design and Construction Standards, a lower impervious area development threshold for meeting design standards will result in more private water quality facility installations. The City wishes to expand its private stormwater facility inspection program to include low impact development applications (LIDA) on single family residential sites. This programmatic activity would be supported by an increase in staffing as opposed to an annual funding mechanism.

6.2.3 Water Quality Facility Retrofits

Per requirements of the CWS NPDES permit, another method for improving stormwater quality focuses on expanding of water quality treatment through the ongoing identification of water quality retrofit opportunities. Such efforts directly address current NPDES permit requirements related to the development and implementation of a retrofit strategy and the need for increased stormwater pollutant load reduction.

Water quality opportunity areas and water quality projects have been identified as part of the project planning process (Section 3.1.1). Additional project reconnaissance efforts conducted by the City and CWS (see Appendix I) identified the following additional retrofit opportunity locations, although a stand-alone capital project need was not identified at this time:

- **Boones Ferry Road and Iowa Street** (Green Street installation).
- **Boones Ferry Road across from Logan Lane** (Green Street installation).
- **125th Avenue to Herman Road** (Public-Private Partnership for a water quality facility installation during redevelopment).
- **SW 95th Avenue at SW Tualatin-Sherwood Road** (Public-Private Partnership for a water quality facility installation during redevelopment or a Green Street installation).
- **SW Teton Road and SW Herman Road Intersection** (regional facility).
- **SW Nyberg Street at SW 65th Avenue** (rehabilitation of an existing water quality facility).

As part of this SMP effort, the City also identified a need for an annual program to validate and construct opportunistic water quality retrofits, as additional opportunity areas are likely to be identified throughout the duration of this SMP's implementation. Such retrofits may include larger-scale regional facilities or installing green streets in conjunction with transportation improvement projects. Efforts should prioritize project opportunities identified through annual inspection efforts, including those priority locations listed above.

6.3 Capital Project and Program Development

Findings from the maintenance assessment, in conjunction with the programmatic activity workshop and supplemental site visits, were used to identify stormwater project and program needs in support of improved and proactive system maintenance.

6.3.1 Capital Project Needs

Six capital projects, originally identified during the project needs assessment (Section 3.1) and as Stormwater Project Opportunity Areas, were developed to address condition-related deficiencies with piped stormwater infrastructure and priority maintenance deficiencies with public water quality facilities.

Capital project fact sheets including project descriptions, project considerations, and preliminary costs are included in Appendix A.

- **Water Quality Facility Restoration-Venetia (CIP 13).** This project includes restoring a failing public water quality facility. Project activities include clearing brush and vegetation, removing sediment and regrading, installing amended soils, and replanting. This location is associated with Stormwater Project Opportunity Area 2.
- **Water Quality Facility Restoration-Piute Court (CIP 14).** This project includes restoring a failing public water quality facility. Project activities include installing a maintenance access road, clearing brush and vegetation, removing sediment and regrading, installing amended soils, replanting with a temporary irrigation system, and replacing the outlet structure. This location is associated with Stormwater Project Opportunity Area 11.
- **Water Quality Facility Restoration–Sequoia Ridge (CIP 15).** This project includes restoring a failing public water quality facility. Project activities include clearing trees and vegetation, removing sediment and regrading, installing amended soils, installing energy dissipation, replanting with a temporary irrigation system, and replacing the outlet structure. This location is associated with Stormwater Project Opportunity Area 12.

- **Water Quality Facility Restoration–Sweek Drive Pond (CIP 16).** This project includes restoring a failing public water quality facility. Project activities include clearing trees and vegetation, removing sediment, installing amended soils, installing an upstream water quality manhole, replanting with a temporary irrigation system, and installing an outlet control structure. This location is associated with Stormwater Project Opportunity Area 13.
- **Siuslaw Water Quality Facility Retrofit (CIP 17).** This project includes replacing 450 feet of failing stormwater pipe and adds water quality treatment at the outlet. This location is associated with Stormwater Project Opportunity Area 6.
- **Water Quality Facility Restoration–Waterford (CIP 18).** This project includes restoring a failing public water quality facility. Project activities include clearing vegetation, removing sediment and regrading, installing amended soils, replanting with a temporary irrigation system, and relocating and replacing the outlet control structure. This location is associated with Stormwater Project Opportunity Area 14.

6.3.2 Program Needs

Results from the project needs assessment (Section 3.1) and maintenance assessment indicate annual programs are needed to proactively address maintenance-related deficiencies.

Cost assumptions related to these programs are detailed in Section 7.

- **Pipe Repair and Replacement Program.** Establishes an annual funding mechanism for pipe R/R. Initial dedicated funds can support development of a baseline condition assessment, including review of existing CCTV in accordance with defined evaluation metrics, coding, and scoring. The National Association of Sewer Service Companies provides a consistent and standard evaluation process for pipes and underground structure conditions. Annual program cost obligations, in addition to staff resources, have been established.
- **Structure R/R Program.** Establishes an annual funding mechanism for structural facility (catch basins, ditch inlets, flow control structures, and manholes) R/R. Initial dedicated funds can support development of a baseline condition assessment. Annual program cost obligations, in addition to staff resources, have been established.
- **Public Water Quality Facility Maintenance Program.** Establishes an annual funding mechanism to conduct routine maintenance (vegetation removal, sediment removal) and restorative maintenance (sediment and regrading, addition of amended soils, replanting, new infrastructure) for public water quality facilities. Immediate needs should be based on annual inspection efforts. Annual program cost obligations, in addition to staff resources, have been established.
- **Public Water Quality Retrofit Program.** Establishes an annual funding mechanism expand water quality treatment throughout the City. Efforts would focus on rehabilitating or retrofitting existing public water quality facilities to promote additional infiltration and/or flow management, planning activities in support of regional water quality retrofit facility installations, and installation of green streets in conjunction with transportation improvement projects. Efforts may include developing a dedicated program, responding to public inquiries, preliminary facility sizing, and detailed design/construction. Annual program cost obligations have been established.
- **Single Family LIDA Inspection Program.** Dedicates staff resources to expand the existing private water quality facility inspection program to single-lot/single family LIDA applications. Annual staff resources have been established.

Section 7

Capital Improvement Plan

This section summarizes the capital project and program recommendations identified throughout the master planning process. Project and program recommendations stem from the water quality assessment (summarized in Section 3.1.1), capacity evaluation (Section 4), stream assessment (Section 5), and maintenance assessment (Section 6).

A total of 21 capital projects were identified to address current and future needs related to water quality, capacity/flooding, system condition and repair, maintenance, and stream health. Six program recommendations to address R/R, system maintenance, and ongoing water quality retrofits were also identified.

7.1 Summary of Recommended Actions

Projects, programs and policy recommendations in this SMP are proposed to improve and enhance drainage infrastructure and water resources throughout the city, as summarized by the following recommended actions:

- Implement identified system capacity improvements (i.e., reconfiguration, rerouting, upsizing) to manage more frequent, nuisance system flooding.
- Increase water quality treatment throughout the city by expanding treatment area coverage through water quality retrofits and enhancing the level of treatment provided.
- Conduct proactive maintenance of the City's stormwater infrastructure. Utilize system condition data currently collected (i.e., stormwater facility inspections, CCTV) to evaluate needs and priorities.
- Consider the topographic limitations and flat grade of the City's conveyance network with regards to system maintenance activities. Sediment removal and vegetation management are key maintenance needs to ensure conveyance capacity, and an increase in maintenance activities may be warranted for select areas of the system.
- Continue coordination with CWS to ensure updates to the City's TDC and PW Standards are in line with regulatory drivers and protect stream health.
- Ensure timely implementation of capital projects and programs by establishing updated funding mechanisms and rates. Additional funding is needed to adequately manage the drainage system as material costs increase, flows increase, and the drainage system deteriorates with age and use.

7.2 Capital Project Recommendations

Table 7-1 summarizes the final capital projects list. Figure 7-1, at the end of this section provides an overview of project locations throughout the city. Project fact sheets are provided in Appendix A and include a project description, summary of design considerations, an overview figure, and cost summary.

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Table 7-1. City of Tualatin Stormwater Capital Project Summary

CIP #	Project Name	Project Summary	Project Objectives	Location	Basin/ Waterbody	Project Description	Total Estimated Cost	SDC Eligible Cost	WQ Retrofit	Project Timing		Associated SW Project Opportunity Area ID
										High Priority (2019-2029)	Lower Priority (Future)	
1	Manhasset Storm System Improvements	Project addresses flooding due to undersized channel and pipe system near Tualatin-Sherwood Road to Manhasset Drive.	• Increases System Capacity (Flood Control)	Manhasset Dr (near 10550 SW Manhasset Dr)	Hedges Creek	• Pipe the existing open channel conveyance and upsize select pipe segments. • Replaces the existing 1,050 linear feet (LF) of open channel and 180 LF of 21-inch-diameter pipe with 1,230 linear feet (LF) of 30-inch-diameter pipe. • Replaces the existing 750 LF of 27-inch-diameter pipe from Manhasset Drive to the outfall to Hedges Creek with 750 LF of 36-inch-diameter pipe. • Includes landscaping, nine new manholes and a new outfall to Hedges Creek.	$1,581,000	$237,000			X	4
2	Nyberg Creek Stormwater Improvements	Project addresses under sized pipes and ongoing maintenance issues near Nyberg Creek between Boones Ferry Road and Martinazzi Avenue.	• Increases System Capacity (Flood Control) • Increases WQ Treatment (Retrofit)	Boones Ferry Rd (19417 SW Boones Ferry Rd)	Nyberg Creek	• Upsize undersized pipe segments, relocating StormFilter catch basin units, and rerouting stormwater flow. • Project is broken up into three phases due to costs: • Phase 1: Install a new trunkline down Martinazzi Avenue from Mohawk Street to Nyberg Creek. • Phase 2: Install a 48-inch pipe along Warm Springs Street and a new outfall to Nyberg Creek. • Phase 3: Upsize storm system along Boones Ferry Road and divert flow to the new system on Warm Springs Street	Phase 1: $1,523,000 Phase 2: $1,252,000 Phase 3: $637,000	Phase 1: $289,000 Phase 2: $238,000 Phase 3: $121,000	X	X (Phase 1)	X (Phases 2 and 3)	5
3	Sandalwood Water Quality Retrofit	Project addresses erosion and capacity concerns related to an open channel conveyance system.	• Addresses Erosion • Increases WQ Treatment (Retrofit)	Sagert St. - Shenandoah Apts (Sandalwood)	Nyberg Creek	• Regrade the existing open channel conveyance. • Install planting for enhanced WQ treatment. • Widen and regrade the existing open channel conveyance, resulting in a 10' wide by 220' long swale. • Install outfall protection and check dams. • Install a new ditch to prevent debris accumulation. • Replace existing ditch inlet with a manhole and connect to new ditch.	$107,000	$25,000	X		X	9
4	Mohawk Apartments Stormwater Improvements	Project addresses limited capacity system at Mohawk Apts to eliminate downstream flooding.	• Increases System Capacity (Flood Control) • Addresses Maintenance Need	Mohawk Apartments	Nyberg Creek	• Install 1,000 LF of CCTV video inspection to determine/ verify the pipe condition, location, material and size. • Install three manholes along the pipe alignment for maintenance access.	$295,000	$59,000			X	10
5	Herman Road Storm System	Project addresses areas of frequent flooding due to limited grade and a lack of drainage infrastructure.	• Increases System Capacity (Flood Control)	Herman Rd	Hedges Creek	• Install 110 LF of 30-inch-diameter pipe • Install 960 LF of 36-inch-diameter pipe • Install 10 manholes, 4 connections to existing stormwater pipes/culverts, and 12 catch basins with an associated 420 LF of 12-inch inlet leads.	$1,023,000	$276,000		X		7
6	Blake St. Culvert Replacement	Project addresses undersized culvert and failing rock wall due to erosive flows.	• Increases System Capacity (Flood Control) • Addresses Erosion	Curves at Blake/105th and 108th	Hedges Creek	• Replace the existing culvert with an 84-inch culvert, along the natural stream alignment.	$552,000	$121,000		X		8
7	Boones Ferry Railroad Conveyance Improvements	Project addresses ongoing maintenance issue, flooding and backwater conditions.	• Addresses Maintenance Need • Increases System Capacity (Flood Control) • Addresses Erosion	RR Culvert behind former Oil Can Henrys		• Install large rock along the railroad ballast. • Upsize downstream pipe to increase flow capacity and improve maintenance access. • Remove existing gravel and ballast material along 150 ft of the open conveyance channel. • Install Class 100 rip-rap along the railroad ballast to reduce the potential for material transport. • Install a new ditch inlet to minimize hydraulic losses at the upstream end of the pipe. • Replace 480 LF of 36-inch-diameter pipe with 42-inch-diameter pipe. • Install a 72-inch manhole along pipe alignment for improved maintenance access. • Install a new outfall to the open channel area directly west of Boones Ferry Road. Add rip-rap for energy dissipation.	$515,000	$108,000			X	5
8	89th Avenue Water Quality Retrofit	Project adds pretreatment/ WQ treatment for Hedges Creek wetland and addresses requirement of the NPDES Permit	• Increases WQ Treatment (Retrofit)	89th Ave/Tualatin-Sherwood Rd Stormwater Outfall	Hedges Creek	• Install a Contech CDS hydrodynamic separator (Model CDS3025) with a treatment flow rate of 2.4 cfs. • Install 50 LF of 24-inch-diameter pipe and 100 LF of 48-inch-diameter pipe.	$262,000	-	X		X	15

Table 7-1. City of Tualatin Stormwater Capital Project Summary

CIP #	Project Name	Project Summary	Project Objectives	Location	Basin/ Waterbody	Project Description	Total Estimated Cost	SDC Eligible Cost	WQ Retrofit	Project Timing		Associated SW Project Opportunity Area ID
										High Priority (2019-2029)	Lower Priority (Future)	
9	125th Court Water Quality Retrofit	Project adds pretreatment/ WQ treatment for Hedges Creek wetland and addresses requirement of the NPDES Permit.	• Increases WQ treatment (Retrofit)	125th to Herman Rd	Cummins Creek	• Install a Contech™ CDS hydrodynamic separator (Model CDS3025), with a treatment flow rate of 2.4 cfs. • Install 50 LF of 24-inch-diameter pipe and 50 LF of 36-inch-diameter pipe to support connections to existing infrastructure.	$206,000	$74,000	X		X	16
10	93rd Avenue Green Street	Project addresses WQ retrofit objectives of the NPDES Permit through a pilot green street project.	• Increases WQ treatment (Retrofit)	93rd Ave	Nyberg Creek	• Install stormwater planters (with an underdrain and overflow) to treat approximately 15,000 sf of impervious surface from the roadway, sidewalks and property frontage along the unimproved right-of-way. • Install 550 LF of curb and gutter along 93rd Avenue to direct stormwater runoff to the WQ facilities. • Connect outlets of the WQ facilities to existing stormwater infrastructure on 93rd Avenue.	$224,000	-	X		X	17
11	Juanita Pohl Water Quality Retrofit	Project adds WQ treatment in a parking area that discharges to Hedges Creek.	• Increases WQ treatment (Retrofit)	Juanita Pohl Parking Lot	Hedges Creek	• Regrade existing landscape islands to install raingardens for WQ treatment. • Excavate and regrade landscape areas and back fill with drain rock and amended soils to support the WQ facility installation. • Install of check dams to minimize potential erosion. • Install curb and curb cuts to serve as inlets to the facilities and associated piping to connect the facility overflows to downstream structures (i.e., manholes). • Plant the facility with native vegetation suitable for a WQ facility. • Minor repaving of parking stalls near the facilities.	$156,000	-	X	X		20
12	Community Park Water Quality Retrofit	Project adds WQ treatment in a parking area associated with the Tualatin Community Park.	• Increases WQ treatment (Retrofit)	Community Park	Hedges Creek	• Regrade existing landscape islands to install raingardens for WQ treatment. • Excavate and regrade the landscape areas and back fill with drain rock and amended soils. • Address existing utilities, light pole, signage, etc. • Install curb and curb cuts to serve as inlets to the facilities and associated piping to connect the facility overflows to downstream structure (i.e., manhole). • Plant the facility with native vegetation suitable for a WQ facility.	$158,000	-	X	X		22
13	Water Quality Facility Restoration - Venetia	Project restores a failing WQ facility.	• Addresses maintenance need • Improves WQ	Venetia WQ Facility Failing (Lee between 56th and 57th)	Saum Creek	• Restore a public WQ facility. • Clear trees and large brush growing in the swale. • Remove accumulated sediment along swale bottom, regrade and replace with amended soils and mulch. • Replant facility with native vegetation suitable for a WQ facility.	$65,000	-		X		2
14	Water Quality Facility Restoration – Piute Court	Project restores a failing WQ facility.	• Addresses maintenance need • Improves WQ	Piute Ct. WQ Facility	Saum Creek	• Restore a public WQ facility. • Install 100 LF gravel access road in the easement located between homes on Piute Court. • Remove accumulated sediment and invasive vegetation, regrade the existing facility, and add amended soils and mulch. • Replant the bottom and sides of facility with riparian/wetland vegetation. Add temporary irrigation. • Install an energy dissipation pad at the pond inlet. • Replace the existing ditch inlet with an outfall control structure. • Install a WQ manhole upstream of the facility in Piute Court.	$104,000	-		X		11
15	Water Quality Facility Restoration – Sequoia Ridge	Project restores a failing public WQ facility.	• Addresses maintenance need • Improves WQ	Sequoia Ridge WQ Facility	Saum Creek	• Restore a public WQ facility. • Clear all cottonwood trees and other vegetation from the facility. • Remove accumulated sediment and invasive vegetation and add amended soils. • Replant the bottom and sides of facility with riparian/wetland vegetation suitable for a stormwater pond. Add temporary irrigation. • Install energy dissipation pad at pond inlet. • Redesign the outlet control structure to have functional low flow pipe and high flow overflow. • Remove the current cap and install an overflow plate.	$83,000	-		X		12

Table 7-1. City of Tualatin Stormwater Capital Project Summary

CIP #	Project Name	Project Summary	Project Objectives	Location	Basin/ Waterbody	Project Description	Total Estimated Cost	SDC Eligible Cost	WQ Retrofit	Project Timing		Associated SW Project Opportunity Area ID
										High Priority (2019-2029)	Lower Priority (Future)	
16	Water Quality Facility Restoration – Sweek Drive Pond	Project restores a failing public WQ facility.	• Addresses maintenance need • Improves WQ	Sweek Dr. WQ pond	Hedges Creek	• Restore a public WQ facility. • Install a new outlet control structure to better utilize storage. • Clear all cottonwood trees and other vegetation from the facility. • Remove accumulated sediment and invasive vegetation and add amended soils. • Replant the bottom and sides of the facility with native vegetation suitable for a stormwater pond. Add temporary irrigation. • Install a WQ manhole upstream of the pond to minimize sediment loading. • Install an energy dissipation pad at the pond inlet and outlet.	$103,000	-		X		13
17	Siuslaw Water Quality Facility Retrofit	Project replaces failing infrastructure and adds WQ treatment.	• Addresses maintenance need • Increases WQ treatment (Retrofit)	Alsea/BF Rd 99th/Siuslaw Greenway	Hedges Creek	• Replace stormwater conveyance system from Boones Ferry to the outfalls at the existing greenway. • Install 350 LF of 30-inch-diameter pipe and 100 LF of 48-inch-diameter pipe. • Install a flow splitter/WQ manhole. • Install or replace 3 catch basins, 2 manholes, and the installation of 5 check dams/energy dissipation. • Grade the existing open channel conveyance to serve as a 15-ft-wide by 500-ft-long bioswale.	$454,000	$104,000	X		X	6
18	Water Quality Facility Restoration - Waterford	Project restores a failing public WQ facility.	• Addresses maintenance need • Improves WQ	Waterford WQ Facility	Hedges Creek	• Restore a public WQ facility. • Clear invasive and unwanted vegetation from the facility. • Excavate and regrade as needed to maximize WQ function and restore to original design. • Remove accumulated sediment and replace with amended soils. • Replant the swale and bottom and sides of the pond facility with native vegetation suitable for a swale and WQ pond. Add temporary irrigation. • Relocate and replace the outlet control structure to the edge of pond for improved maintenance access. • Replace inlet rip rap for increased energy dissipation. • Install two WQ/flow splitter manholes upstream of facility to minimize sediment loading.	$180,000	-		X		14
19	Saum Creek Hillslope Repair	Project replaces infrastructure that is in poor condition and addresses existing slope instability.	• Addresses maintenance need • Addresses erosion	Recent outfall retrofit (Blake St at Saum Creek)	Saum Creek	• Replace the storm pipe from Makah Ct. to the outfall and outfall reconstruction and extension to the stream channel. • Conduct hillslope rehabilitation (rock buttresses or import new fill material) in conjunction with the pipe and outfall replacement to incorporate energy dissipation and be minimize future erosion and slope instability.	$171,000	-		X		3
20	Hedges Creek Stream Repair	Project addresses instream channel erosion and threatened public infrastructure.	• Addresses erosion	SW 106th Ave and Willow Street at Hedges Creek	Hedges Creek	• Site 'N': Install an outfall extension, bioengineered slopes, streambed fill and vegetation restoration. • Site 'M': Install an open channel excavation, stream bed fill, and installation of a retaining wall.	$327,000	-		X		N/A
21	Nyberg Creek Water Quality Facility	Project adds regional WQ treatment.	• Increases WQ treatment (Retrofit)	Warm Springs Street at City-owned parcel adjacent to Nyberg Creek	Nyberg Creek	• Clear invasive and unwanted vegetation; excavate and grade City-acquired property to support facility installation. • Install low flow bypass structure, 485 LF of 12-inch diameter pipe, and 275 LF of 24-inch-diameter pipe on Warm Springs Street between Martinazzi Avenue and the facility. • Install 4 manholes, 3 catch basins, and inlet leads along Warm Springs Street. • Install an approximately 1-acre tiered WQ facility with beehive overflows. A maintenance access road will also be needed. • Install a flow control structure and debris forebay in the WQ facility and a high-flow bypass channel around the facility. • Install a new open channel conveyance to outfall at Nyberg Creek.	$2,037,000	$265,000	X	X		N/A

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7.2.1 Integrated Project Development

Integrated project development refers to the selection and design of capital projects to address multiple objectives. Project objectives are reflected in Table 7-1 and include:

- Increase system capacity (flood control)
- Address erosion
- Increase water quality treatment (retrofit)
- Improve water quality
- Address maintenance need

Projects identified to improve water quality are associated with existing site or facility modifications/restoration to address a pollutant source issue or improve treatment function and are, therefore, not considered a retrofit.

This SMP used an integrated approach for project identification and development efforts, starting with the initial identification of project needs and Stormwater Project Opportunity Areas and then the consolidation of Stormwater Project Opportunity Areas into single, multi-objective project concepts where possible (Section 3).

An integrated project development approach was specifically used during the water quality opportunity assessment (Section 3.1.1). Capacity and maintenance-related project needs were prioritized when considering opportunities for water quality enhancement and retrofit. As project concepts were developed and refined, continued opportunities for water quality elements were considered and incorporated. Integrated project examples that reflect the combination of capacity and water quality include CIP 2, Nyberg Creek Stormwater Improvements; CIP 3, Sandalwood Water Quality Retrofit; and CIP 17, Siuslaw Water Quality Facility Retrofit.

The maintenance assessment also recognized that certain capacity-related deficiencies may also be addressed through maintenance-related activities. Integrated project examples reflecting capacity and maintenance related project needs include CIP 4, Mohawk Apartment Stormwater Improvements; and CIP 7, Boones Ferry Railroad Conveyance Improvements.

7.2.2 Sizing and Design Assumptions

Capital project sizing and design assumptions were based on the type of improvement proposed. Sizing and design assumptions generally followed the City's Public Works Standards and/or CWS's Design and Construction Standards (2012) or LIDA Handbook (2009).

Project concepts are reflective of an approximate 10%design level. Conceptual layout and design considerations are included in the project fact sheets (Appendix A).

- **Capacity Projects.** Projects to construct new conveyance infrastructure or replace existing conveyance infrastructure were developed following the City's PW Standards. All capacity projects in this SMP were sized for the 25-year, 24-hour design event. Although system surcharging is not permissible per the City's design standards, given the flat grade of much of the existing City infrastructure, system surcharging was deemed permissible for capital projects.
- **Water Quality Projects**. Water quality projects were generally designed according to CWS's LIDA Handbook. Proprietary system vendors were contacted to verify sizing where proprietary treatment systems were proposed (i.e., CIP Nos. 2, 8, and 9). As select retrofit projects could not be reasonably sized within area constraints to manage the full water quality treatment flow/volume, facility sizing was based on maximizing water quality treatment within the available area (i.e., CIP 21).

- **New Infrastructure.** Several projects require new infrastructure in locations where no storm system exists. Conceptual layouts are illustrated in the project fact sheets (Appendix A) and reflect new infrastructure proposed in the public ROW only; however, detailed design must consider/allow for potential utility conflicts and realignment needs. Survey will be required to verify elevations and locations. Final design may require additional structures, an alternate alignment due to conflicts, or deeper or shallower pipes than assumed for the conceptual project design.

7.2.3 Cost Assumptions

Project costs are based on the total capital investment necessary to complete a project (i.e., engineering through construction). Costs are based on the proposed layout and general design assumptions as documented in the project fact sheets (Appendix A).

Unit prices for construction elements are based on recent bid tabs and previous local stormwater master planning efforts, adjusted for 2018 based on a historical cost index. The current RS Means *Book for Site Work and Landscaping* was referenced for material costs not previously identified. Cost estimates presented in this SMP are AACE Class 5 Conceptual Level or Project Viability Estimates. Actual costs may vary from these estimates between -50 percent to +100 percent, although changes to design may result in cost differences outside of this anticipated range.

Preliminary cost estimates were based on the unit cost information for construction elements plus a 30 percent construction contingency and multipliers to account for mobilization/demobilization, traffic control and utility relocation, and erosion control. Engineering and permitting costs (15 to 35 percent) and construction administration costs (10 percent) were applied as a general percentage to the total construction cost with contingencies. The range in engineering and permitting costs were based on the anticipated permitting level of effort, including whether in-water work is anticipated, which would warrant environmental permitting efforts in conjunction with Section 404 of the CWA. For planning purposes, costs were rounded to the nearest $1,000.

Land acquisition and easement costs were not included in the estimates, as most projects are located on City property or within the City right-of-way.

Appendix G includes the unit cost table developed for this SMP and the planning-level cost estimates for each project. Staffing resource assumptions to implement these projects are described in Section 8.1.1.

7.3 Program Recommendations

Six program needs were identified to address water quality, stream health, system maintenance, and asset management of stormwater infrastructure.

During the programmatic activity workshop (Section 6.2), City staff reviewed cost assumptions associated with implementing the proposed programs. Program costs vary based on existing City funding levels and coverage or extent of activity anticipated. Table 7-2 summarizes the resulting program cost summary, accounting for the City’s current annual funding obligations.

Program Activity	Current Annual Obligation [a]	Proposed Program Cost	Project Duration Assumptions	Additional Program Funding (annual) [b]
Pipe R/R Program	$25,000	$125,000	100-years	$100,000
Structure R/R Program	$19,400	$120,000	100-years	$100,000
Public WQ Facility Maintenance Program	$25,000	$150,000	Ongoing	$125,000
Public WQ Facility Retrofit Program	N/A	$75,000	Ongoing	$75,000
Stream Vegetation Management	N/A	$100,000	Ongoing	$100,000
Single Family LIDA Inspection Program	N/A	N/A	10-year	N/A

Table 7-2. Programmatic Activities and Cost Estimates

a. Refer to Table 6-2.

b. Based on subtraction of the current annual obligation. Assumes that the current annual obligation will be maintained in the future.

Cost assumptions by program are detailed below. Staffing resources to implement these proposed programs are described in Section 8.1.2.

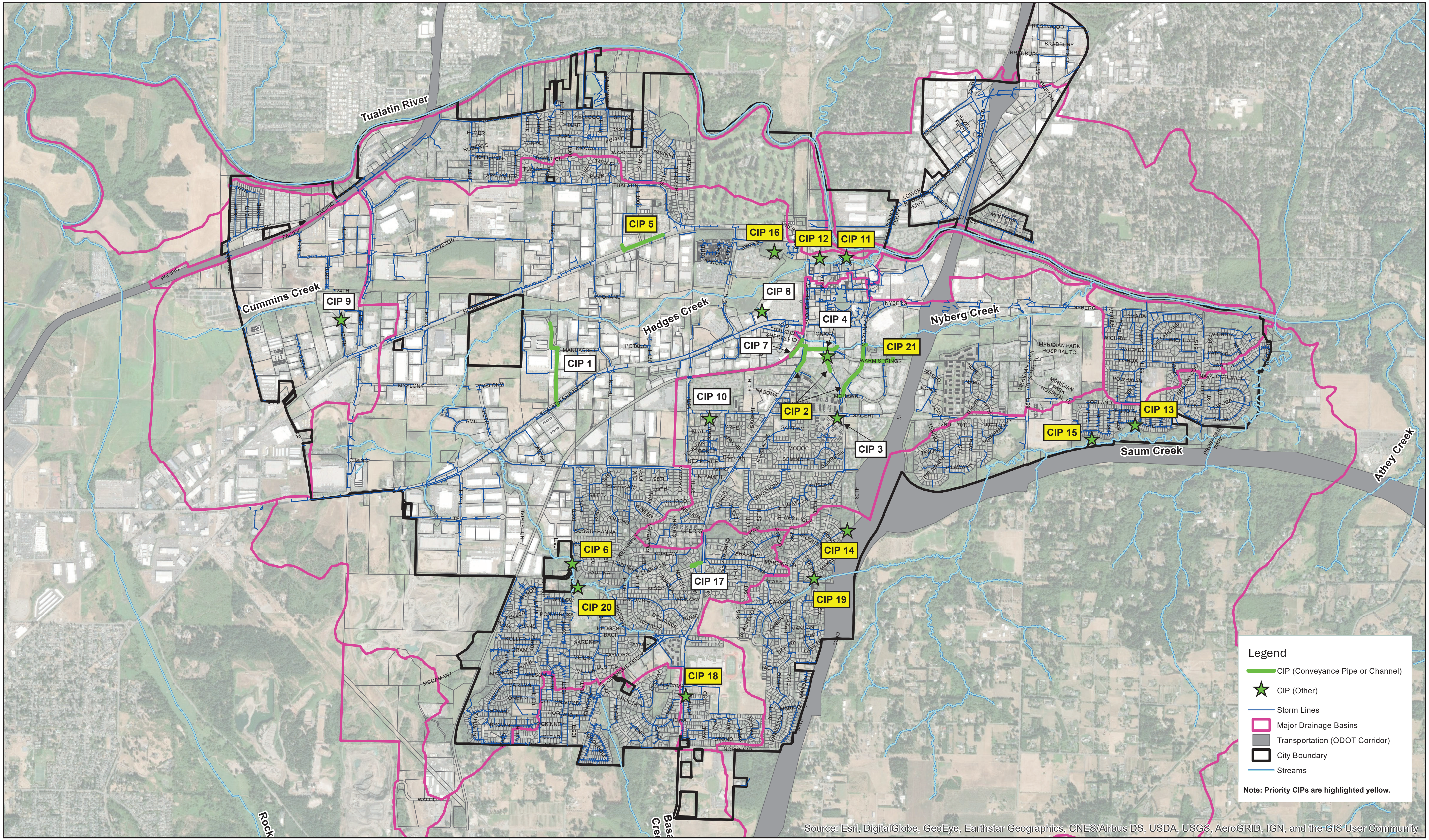
- **Pipe R/R Program.** Cost assumptions were based on replacing 486,000 LF of public storm line over a 100-year planning period (i.e., 1 percent of pipes replaced annually). Pipe replacement costs assumed a consistent size distribution as the current inventory. Present worth analysis indicated an annual cost between $1 million and $1.25 million would be required; however, due to ongoing pipe replacement efforts and unknowns related to lifespan, the City opted to allocate approximately 10 percent of the annually calculated amount ($125,000) for budgeting purposes. The additional annual allocation was $100,000, assuming a current annual allocation of $25,000.

  Efforts should first establish a baseline system condition from current CCTV results. R/R efforts should be prioritized based on condition assessment and reported deficiencies.
- **Structure Repair and Replacement Program.** Cost assumptions were based on replacing or restoring public catch basins, ditch inlets, flow control structures, and manholes over a 100-year planning period (i.e., 1 percent of structures replaced annually). Replacement costs assumed consistent facility distribution as reflected in the City's current asset inventory. Restoration costs assumed a lump sum of $2,000 per structure. Present worth analysis indicated an annual cost between $140,000 to $240,000 would be required; however, due to ongoing structure replacement efforts and unknowns related to lifespan, the City opted to allocate 50 percent of the maximum annually calculated amount for budgeting purposes ($120,000). The additional annual allocation is $100,000, assuming a current annual allocation of approximately $20,000.
- **Public Water Quality Facility Maintenance Program.** Cost assumptions considered both routine (minor) and restorative needs for public water quality facilities. Typical extensive/restorative facility maintenance ranges from $75,000 to $100,000 (based on cost estimates developed for projects as part of this Plan). Routine maintenance efforts can vary (assume $50,000). The total annual allocation proposed is $150,000. The additional annual allocation is $125,000, assuming a current annual allocation of $25,000.

  Efforts should prioritize facilities currently identified by staff as requiring maintenance (see Section 6.2.2).
- **Public Water Quality Retrofit Program.** Costs are based on anticipated annual efforts to identify potential retrofit opportunities annually, respond to public inquiries, conduct preliminary facility sizing, and provide oversight of detailed design/construction. Funds may be used internally or contracted externally. The total proposed annual allocation is $75,000 and should prioritize

locations currently identified by staff or additional retrofit opportunities identified by CWS during their review of this Plan (see Section 6.2.3 and Appendix I).

- **Stream Vegetation Management Program.** Cost assumptions were based on removing 0.5 acres of invasive vegetation per year at a unit cost of $4.60/square foot (sf). The total proposed annual allocation is $100,000. Funds may be used internally or contracted externally.
- **Single-Family LIDA Inspection Program.** Costs assumed an expanded number of private stormwater facility inspections (10 additional facilities with a 10 percent annual increase). Staff resources are required, and a proposed annual fund allocation is not included.



Brown AND Caldwell

City of Tualatin

City of Tualatin

Stormwater Master Plan

Date: April 2019
Project: Project 149233

N

0 2,050 4,100 Feet

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 7-1

Capital Project Location Overview

Section 8

Implementation

This SMP includes a financial evaluation to determine rate adjustments required to implement projects and programs identified in this Plan.

This section provides an overview of staffing needs, project prioritization, operational costs and established levels of service (LOS) reflected in the stormwater utility rate and SDC evaluation. This section also summarizes results of the rate evaluation.

8.1 Staffing Analysis

The City's public works department includes seven FTEs in engineering and six FTEs in operations that currently support stormwater project and program needs. Current staffing levels are considered adequate to support existing commitments, project obligations, and program implementation, but an increase in staff resources is needed to implement capital projects and programs proposed under this SMP.

Appendix H, Table H-1 summarizes the comprehensive results of the staffing analysis for purposes of informing the financial evaluation. Staffing needs for capital projects were incorporated directly into the project cost, while staffing needs for programs were estimated for each individual program. A total of 0.6 FTEs (administration, engineering and maintenance staff) is required to implement all projects identified in this SMP over a 10-year implementation period. A total of 0.4 FTEs is required to implement proposed programs over the next 10-year implementation period. If the City intends to implement only priority projects over the next 10-year implementation period, a total of 0.7 FTEs is required to implement priority projects and all proposed programs (see Section 8.2 for discussion of priority project needs).

8.1.1 Capital Project Staffing Assumptions

For capital projects, additional staffing needs are anticipated to support capital project administration, project management, and the ongoing maintenance of new assets. Staffing estimates to support capital projects were based solely on the conversion of the construction administration cost to an FTE based on an annual salary (cost) equivalent of $150,000. The total FTE estimate to implement capital projects was then converted to an annual staff allocation based on a 10-year implementation period. Construction administration costs are estimated at 10 percent of the capital expense subtotal (see Appendix G for detailed cost estimates by project).

For reference purposes only, Table H-1 also includes an estimate of maintenance staff time, based on the new infrastructure proposed with the capital project, to support the capital project implementation. Although maintenance staff time was accounted for with the staffing calculation for capital projects described above, it is recognized that select capital projects may require maintenance outside of the City's current maintenance obligations and frequencies to ensure optimum performance, while other capital projects that include replacing existing infrastructure may not require additional maintenance activities, as the existing infrastructure would already be maintained.

Table 8-1 summarizes the maintenance-related cost assumptions used to summarize the estimated maintenance staff needs. The City does not currently track maintenance activities or log maintenance staff hours in time sheets or as part of an asset management program; therefore, maintenance staff time assumptions were based on typical rates and confirmed with City staff. Maintenance staffing resource needs are calculated in hours and converted to an FTE, based on a typical FTE workload of 2,080 hours.

Table 8-1. Maintenance Staff Time Summary		
Maintenance Activity	Average Time Calculation	Maintenance Frequency
Pipe/open channel conveyance cleaning	20'/hour	Annual
Outfall debris removal	4 hours/outfall	Annual
Catch basin maintenance	1 hour/facility	Annual
Water quality facility (swale) maintenance	20'/hour	Annual
Water quality facility (StormFilter or CDS) maintenance	6 hours/facility	Annual
Water quality facility (planter or raingarden) maintenance	50 square feet/hour	Annual
Water quality facility (WQ manhole) maintenance	1 hour/facility	Biannual
Water quality facility inspections	1 hour/facility	Quarterly

Please note that engineering and permitting costs (estimated between 15 and 35 percent of the capital expense subtotal) were included in the capital project cost estimates but not reflected in the staffing costs. The City currently assumes that all engineering and permitting activities will be contracted, so additional staff time to perform engineering and permitting services is not reflected in the staffing analysis.

8.1.2 Program Staffing Assumptions

For select programs, there may also be an increase in engineering and/or maintenance staff needs; however, there are many considerations that would influence staffing levels.

Program-specific estimates of additional engineering and maintenance staff resource needs are listed in Table 8-2 and have been summarized in Appendix H, Table H-1. In general, maintenance and R/R programs require additional engineering staff to evaluate and identify project locations and needs, review maintenance/CCTV records, and contract needed repairs. Additional maintenance staff resources are needed to expand condition assessment efforts to structures.

Costs for implementing an expanded public water quality facility maintenance program, public water quality facility retrofit program, and vegetation management program are estimated as a lump sum that may be spent either on contracted or internal support. Thus, additional staff resources are limited to engineering support, and additional maintenance needs have not been separately identified. Implementing an expanded water quality facility inspection program for single-family LIDA is a staff activity, and the cost is solely accounted for in the staffing analysis.

Program Activity	Proposed Program Cost [a]	Additional Funding Need [a]	Additional Staffing Resources (Engineering)	Additional Staffing Resources (Maintenance)
Pipe R/R Program	$125,000	$100,000	• 0.10 FTE (review and evaluate pipe based on CCTV results, identify additional CCTV needs, PM and contract repairs). • Design and construction to be contracted per proposed program funding.	N/A
Structure R/R Program	$19,400	$100,000	• 0.10 FTE (review and evaluate structures based on condition assessment, PM and contract repairs). • Design and construction to be contracted per proposed program funding.	0.10 FTE (vactor in support of inspections, site prep, and coordination).
Public WQ Facility Maintenance Program	$25,000	$125,000	• 0.05 FTE (identify and document maintenance needs, PM and contract management). • Design and construction to be contracted per proposed program funding.	N/A (efforts to be contracted)
Public WQ Facility Retrofit Program	N/A	$75,000	N/A	N/A
Stream Vegetation Management	N/A	$100,000	N/A	N/A (efforts to be contracted)
Single Family LIDA Inspection Program	N/A	N/A	0.05 FTE (conduct additional inspections assuming 10% annual increase).	N/A

Table 8-2. Annual Program Staffing Needs

a. *Refer to Table 7-2.*

8.2 Project Prioritization

Project prioritization is an important component of the stormwater master planning process and can provide direction in terms of sequencing projects in accordance with City objectives.

The prioritization process was initiated during the programmatic activity workshop (Section 6-2). Example prioritization criteria and scoring methods (qualitative versus quantitative) were provided to City staff to guide their internal process. The City opted to focus prioritization efforts on defining priority projects to be funded over the next 10-year implementation period and not on numeric scoring and specific ranking of projects. Over time, the City may choose to add numeric scoring metrics or weighting factors to refine projects for scheduling or to place more emphasis on specific criteria as new project needs are identified and added to the capital improvement program. Table 8-3 summarizes the general prioritization criteria provided and used by the City as part of its prioritization process.

Table 8-3. Prioritization Criteria

Criteria	Scoring Definition	
	High (H)	Lower (L)
Flooding Issue/ Safety Concern	• Addresses an area of known or significant capacity deficiency or erosion potential. • Was identified as flooding during existing conditions per targeted hydraulic modeling.	No reported flooding concerns or safety issues associated with project location.
WQ Improvement	• Project significantly improves water quality and wildlife habitat. • Project many be classified as a retrofit per CWS.	Project moderately improves or doesn't improve water quality and wildlife habitat.
Maintenance	• Project will reduce existing maintenance needs or complaints. • Project provides increased longevity for facility function.	Occasional maintenance needs or complaints occur in this area.
Concurrence	• Project is required or a prerequisite for other budgeted or inter-jurisdictional projects.	Project is stand-alone and does not affect implementation of other City projects.
Special Interest	• Project has City Council, City staff, or public interest/motivation.	Project has no public driver or interest.

City staff independently evaluated projects in conjunction with prioritization guidelines and criteria and determined those highest priority projects for implementation over the next 10 years. A summary of capital projects and costs, including an indication of those priority projects, is provided in Table 8-4.

Table 8-4. Capital Project Costs and Priorities

Priority Project	CIP Number	CIP Name	Cost Estimates
	1	Manhassat Storm System Improvements	$1,581,000
X (Phase 1)	2	Nyberg Creek Stormwater Improvements (Phases 1-3)	$3,412,000
	3	Sandalwood Water Quality Retrofit	$107,000
	4	Mohawk Apartments Stormwater Improvements	$295,000
X	5	Herman Road Storm System	$1,023,000
X	6	Blake St Culvert Replacement	$552,000
	7	Boones Ferry Railroad Conveyance Improvements	$515,000
	8	89th Avenue Water Quality Retrofit	$262,000
	9	125th Court Water Quality Retrofit	$206,000
	10	93rd Avenue Green Street	$224,000
X	11	Juanita Pohl Water Quality Retrofit	$156,000
X	12	Community Park Water Quality Retrofit	$158,000
X	13	Water Quality Facility Restoration - Venetia	$65,000
X	14	Water Quality Facility Restoration - Piute Court	$104,000
X	15	Water Quality Facility Restoration - Sequoia Ridge	$83,000
X	16	Water Quality Facility Restoration - Sweek Drive Pond	$103,000
	17	Siuslaw Water Quality Facility Retrofit	$454,000
X	18	Water Quality Facility Restoration - Waterford	$180,000
X	19	Saum Creek Hillslope Repair	$171,000
X	20	Hedges Creek Stream Repair	$327,000
X	21	Nyberg Water Quality Retrofit	$2,037,000
		Total	$12,015,000
		Total (Priority projects only)	$6,482,000

8.3 Level of Service

Developing the stormwater rate evaluation requires the City to determine a level of service consistent with the expectations of the City's stormwater program and ratepayers.

Using project cost information, program cost information, and estimated operational funding expenditures, City staff identified the proposed LOS for stormwater-related services. The proposed LOS assumes construction of priority capital projects within a 10-year timeframe. Program expenditures are funded at recommended levels (see Table 7-2). Staffing needs are identified based on implementing priority projects only and all program elements. Operational costs were provided by City staff and account for vehicle replacement needs and rehabilitation of the City's operations building.

Table 8-5. Current and Recommended Level of Service (Criteria)

Criteria	Current LOS	Recommended LOS
Capital Project Implementation		
Stormwater Project Implementation (CIPs)	Implement stormwater capital projects in conjunction with City's 2017-2021 Capital Improvement Plan	Implement priority stormwater capital projects per this SMP in a 10-year planning window
Program Implementation (Annual Cost)		
Pipe R/R	Maintain current funding for repair needs	Expand repair efforts into an R/R program.
Structure R/R	Maintain current funding for repair needs	Expand repair efforts into an R/R program.
Public WQ Facility Maintenance Program	Conduct or contract out minor maintenance needs.	Expand maintenance program to include routine and restorative efforts.
Public WQ Facility Retrofit Program	N/A	Add program
Stream Vegetation Management	N/A	Add program
Equipment/Operational Costs (Annual Cost)		
Vehicle/Equipment Replacement [a]	Variable	Assume annual funding to replace vehicles (cost share with sanitary)
Operations Building Rehabilitation [b]	N/A	$50,000
Staffing (associated with priority capital projects and programs) (FTE)		
Staffing (engineering)	Maintain existing staffing resources	Increase engineering staffing resources by 0.52 FTE to support priority projects and programs.
Staffing (maintenance)	Maintain existing staffing resources	Increase maintenance staffing resources by 0.24 FTE to support priority projects and programs.

a. *The vactor truck replacement is budgeted at $310,000 in FY 2019/20. Following FY 2019/20, vehicle replacement is budgeted at $75,000/year.*

b. *Annual cost provided by City.*

8.4 Funding Evaluation

In conjunction with development of this Plan, a review of the City's stormwater utility rate and SDC was conducted. Documentation of the financial evaluation is provided in a separate TM.

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Section 9

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Section 10

Limitations

This document was prepared solely for City of Tualatin in accordance with professional standards at the time the services were performed and in accordance with the contract between City Tualatin and Brown and Caldwell dated April 14, 2016. This document is governed by the specific scope of work authorized by City of Tualatin; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Tualatin and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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CITY OF TUALATIN

Planning Division

February 8, 2021

Analysis and Findings

Case #: PTA 21-0001

Project: Stormwater Master Plan

TABLE OF CONTENTS

I. **INTRODUCTION**

A. Applicable Criteria

Applicable Statewide Planning Goals; Division 11 of the Oregon Administrative Rules Chapter 660; Metro Chapter 3.02 (Waste Water Management Plan); City of Tualatin Comprehensive Plan Chapter 13; City of Tualatin Development Code, Section 33.070, Plan Amendments.

B. Project Description

Plan Text Amendment (PTA) 20-0001 proposes amendments to the Tualatin Comprehensive Plan Chapters 1 and 9 to reflect the updated version of the Stormwater Master Plan (2020) as well as reference changes in Tualatin Development Code Chapter 74.

The proposed amendments would facilitate future development of stormwater management projects throughout the City and aid development by providing reliable information in the City's development code.

C. Exhibit List

(a) Stormwater Master Plan (2020)

D. Proposed Amendments

The following Text Amendments have been proposed:

Tualatin Comprehensive Plan:

- Addition of Stormwater Master Plan reference in Technical Memoranda section, acknowledging the Master Plan as a support document adopted as part of the Comprehensive Plan.
- Revisions to Chapter 9—Public Facilities and Services, deleting references to previous drainage plan and revising goals and policies consistent with the updated Master Plan.
- Adopting Figure 7-1 of the Stormwater Master Plan (Capital Project Location Overview) as Map 9-3 of the Tualatin Comprehensive Plan.

Tualatin Development Code:

- Replacing references to Tualatin Drainage Plan with reference to Stormwater Master Plan.

The full text amendments are provided in Exhibit A.

II. FINDINGS

A. The following Oregon Statewide Planning Goals are applicable to the proposed amendments:

Goal 1 – Citizen Involvement
To develop a citizen involvement program that insures the opportunity for citizens to be involved in all phases of the planning process.

Finding:
The draft Stormwater Master Plan was opened for a public comment period in Fall 2020. An online "open house" featuring project information and synopsis video were available during the comment period to aid public understanding of the project.

Proposed changes the Tualatin Comprehensive Plan and Development Code are to be additionally discussed at the Tualatin Planning Commission in their capacity as an advisory body on January 21, 2021, and these changes are being vetted at a public hearing with opportunity for additional public testimony before City Council in February 2021. The proposed amendments conform to Goal 1.

Goal 2 – Land Use Planning
To establish a land use planning process and policy framework as a basis for all decision and actions related to use of land and to assure an adequate factual base for such decisions and actions.

[…]

Finding:

The proposed amendments have been reviewed pursuant to the City's established land use planning process and procedures. The existing land use plan references previous documents including the Tualatin Drainage Plan (1979) and Hedges Creek Subbasin Plan, and it is appropriate to incorporate changes into the Comprehensive Plan. The proposed amendments conform to Goal 2.

Goal 6 – Air, Water and Land Resources Quality

Finding:

A functioning stormwater management system is in the best interest of water quality and the protection of other natural resources. The Stormwater Master Plan has been developed in coordination with the applicable regional agencies, including Clean Water Services. The proposed amendments conform to Goal 6.

Goal 11 – Public Facilities and Services

Finding:

The Stormwater Master Plan is intended to serve the needs of present and future development. No extension of services is proposed beyond the Tualatin Urban Planning Area, which is within the Urban Growth Boundary. The proposed amendments conform to Goal 11.

B. The following Oregon Administrative Rules (OAR) are applicable to the proposed amendments:

Chapter 660-011-0000
Public Facilities Planning

660-011-0010
The Public Facility Plan

(1) The public facility plan shall contain the following items:

- **(a) An inventory and general assessment of the condition of all the significant public facility systems which support the land uses designated in the acknowledged comprehensive plan;**
- **(b) A list of the significant public facility projects which are to support the land uses designated in the acknowledged comprehensive plan. Public facility project descriptions or specifications of these projects as necessary;**
- **(c) Rough cost estimates of each public facility project;**
- **(d) A map or written description of each public facility project's general location or service area;**
- **(e) Policy statement(s) or urban growth management agreement identifying the provider of each public facility system. If there is more than one provider with the authority to provide the system within the area covered by the public facility plan, then the provider of each project shall be designated;**
- **(f) An estimate of when each facility project will be needed; and**
- **(g) A discussion of the provider's existing funding mechanisms and the ability of these and possible new mechanisms to fund the development of each public facility project or system.**

(2) Those public facilities to be addressed in the plan shall include, but need not be limited to those specified in OAR 660-011-0005 (Definitions)(5). Facilities included in the public facility plan other than those included in OAR 660-011-0005 (Definitions)(5) will not be reviewed for compliance with this rule.

(3) It is not the purpose of this division to cause duplication of or to supplant existing applicable facility plans and programs. Where all or part of an acknowledged comprehensive plan, facility master plan either of the local jurisdiction or appropriate special district, capital improvement program, regional functional plan, similar plan or any combination of such plans meets all or some of the requirements of this division, those plans, or programs may be incorporated by reference into the public facility plan required by this division. Only those referenced portions of such documents shall be considered to be a part of the public facility plan and shall be subject to the administrative procedures of this division and ORS Chapter 197 (Comprehensive Land Use Planning).

Finding:
The Stormwater System Master Plan (2019) contains information regarding the condition of current stormwater management systems, anticipated capital investments, and details such as location and associated costs. A map and additional descriptions of anticipated capital improvements is included in the plan and proposed to be adopted as Map 9-3 of the Comprehensive Plan. Public facilities have been planned in conjunction with other relevant agencies, especially Clean Water Services. Funding mechanisms including System Development Charges and utility rates is also discussed within the Plan.

Separate sections of the Tualatin Comprehensive Plan address transportation, potable water, and sanitary sewer. No changes to these sections are being proposed with this Plan Text Amendment.

These standards are met.

Rule 660-011-0015
Responsibility for Public Facility Plan Preparation

(1) Responsibility for the preparation, adoption and amendment of the public facility plan shall be specified within the urban growth management agreement. If the urban growth management agreement does not make provision for this responsibility, the agreement shall be amended to do so prior to the preparation of the public facility plan. In the case where an unincorporated area exists within the Portland Metropolitan Urban Growth Boundary which is not contained within the boundary of an approved urban planning area agreement with the County, the County shall be the responsible agency for preparation of the facility plan for that unincorporated area. The urban growth management agreement shall be submitted with the public facility plan as specified in OAR 660-011-0040 (Date of Submittal of Public Facility Plans).

(2) The jurisdiction responsible for the preparation of the public facility plan shall provide for the coordination of such preparation with the city, county, special districts and, as necessary, state and federal agencies and private providers of public facilities. The Metropolitan Service District is responsible for public facility plans coordination within the District consistent with ORS 197.190 and 268.390 (Planning for activities and areas with metropolitan impact).

(3) Special districts, including port districts, shall assist in the development of the public facility plan for those facilities they provide. Special districts may object to that portion of the facilities plan adopted as part of the comprehensive plan during review by the Commission only if they have completed a special district agreement as specified under ORS 197.185 and 197.254 (Bar to contesting acknowledgment, appealing or seeking amendment)(3) and (4) and participated in the development of such portion of the public facility plan.

(4) Those state agencies providing funding for or making expenditures on public facility systems shall participate in the development of the public facility plan in accordance with their state agency coordination agreement under ORS 197.180 (State agency planning responsibilities) and 197.712 (Commission duties)(2)(f).

Finding:
The City of Tualatin is within both Clackamas and Washington Counties and has separate agreements that function as the applicable urban growth management agreement. The City of Tualatin-Clackamas County Urban Growth Management Agreement (1992) (Exhibit XX) recognizes the City's authority for public facilities planning within the UGB in accordance with this administrative rule. The Washington County—City of Tualatin Urban Planning Area Agreement (2019) (Exhibit XX) likewise acknowledges that the City is responsible for the preparation, adoption, and amendment of the public facility plan required by this section. The City has coordinated with Clean Water Services and applicable partners in the

development of the Plan proposed for adoption and relevant text amendments. These standards are met.

Rule 660-011-0020
Public Facility Inventory and Determination of Future Facility Projects

(1) The public facility plan shall include an inventory of significant public facility systems. Where the acknowledged comprehensive plan, background document or one or more of the plans or programs listed in OAR 660-011-0010 (The Public Facility Plan)(3) contains such an inventory, that inventory may be incorporated by reference. The inventory shall include:
(a) Mapped location of the facility or service area;
(b) Facility capacity or size; and
(c) General assessment of condition of the facility (e.g., very good, good, fair, poor, very poor).

(2) The public facility plan shall identify significant public facility projects which are to support the land uses designated in the acknowledged comprehensive plan. The public facility plan shall list the title of the project and describe each public facility project in terms of the type of facility, service area, and facility capacity.

(3) Project descriptions within the facility plan may require modifications based on subsequent environmental impact studies, design studies, facility master plans, capital improvement programs, or site availability. The public facility plan should anticipate these changes as specified in OAR 660-011-0045 (Adoption and Amendment Procedures for Public Facility Plans).

Finding:
The Stormwater Master Plan updates the City's inventory of public facility systems. This inventory includes location data, as well as information about the condition and size or existing facilities. The updated Comprehensive Plan will incorporate this updated inventory information by reference. The Stormwater Master Plan additionally identifies significant projects needed to support further growth and development in Tualatin consistent with the acknowledged Comprehensive Plan. The amendments are consistent with these standards.

Rule 660-011-0025
Timing of Required Public Facilities

(1) The public facilities plan shall include a general estimate of the timing for the planned public facility projects. This timing component of the public facilities plan can be met in several ways depending on whether the project is anticipated in the short term or long term. The timing of projects may be related directly to population growth, e.g., the expansion or new construction of water treatment facilities. Other facility projects can be related to a measure of the facility's service level being met or exceeded, e.g., a major arterial or intersection reaching a maximum vehicle-per-day standard. Development of other projects may be more long term and tied neither to specific population levels nor measures of service levels, e.g., sewer projects to correct infiltration and inflow

problems. These projects can take place over a long period of time and may be tied to the availability of long-term funding. The timing of projects may also be tied to specific years.

(2) Given the different methods used to estimate the timing of public facilities, the public facility plan shall identify projects as occurring in either the short term or long term, based on those factors which are related to project development. For those projects designated for development in the short term, the public facility plan shall identify an approximate year for development. For those projects designated for development over the long term, the public facility plan shall provide a general estimate as to when the need for project development would exist, e.g., population level, service level standards, etc. Timing provisions for public facility projects shall be consistent with the acknowledged comprehensive plan's projected growth estimates. The public facility plan shall consider the relationships between facilities in providing for development.

(3) Anticipated timing provisions for public facilities are not considered land use decisions as specified in ORS 197.712 (Commission duties)(2)(e), and, therefore, cannot be the basis of appeal under ORS 197.610 (Submission of proposed comprehensive plan or land use regulation changes to Department of Land Conservation and Development)(1) and (2) or 197.835 (Scope of review)(4).

Finding:
The Stormwater Master Plan includes information on whether anticipated capital projects are "High Priority (2019-2029) or "Lower Priority (Future)" as seen in Table 7-1. This determination is in relationship to identified system capacity needs. These standards are met.

Rule 660-011-0030
Location of Public Facility Projects

(1) The public facility plan shall identify the general location of the public facility project in specificity appropriate for the facility. Locations of projects anticipated to be carried out in the short term can be specified more precisely than the locations of projects anticipated for development in the long term.
(2) Anticipated locations for public facilities may require modifications based on subsequent environmental impact studies, design studies, facility master plans, capital improvement programs, or land availability. The public facility plan should anticipate those changes as specified in OAR 660-011-0045 (Adoption and Amendment Procedures for Public Facility Plans).

Rule 660-011-0035
Determination of Rough Cost Estimates for Public Facility Projects and Local Review of Funding Mechanisms for Public Facility Systems

(1) The public facility plan shall include rough cost estimates for those sewer, water, and transportation public facility projects identified in the facility plan. The intent of these rough cost estimates is to:
(a) Provide an estimate of the fiscal requirements to support the land use designations in the acknowledged comprehensive plan; and
(b) For use by the facility provider in reviewing the provider's existing funding mechanisms (e.g., general funds, general obligation and revenue bonds, local improvement district, system development

charges, etc.) and possible alternative funding mechanisms. In addition to including rough cost estimates for each project, the facility plan shall include a discussion of the provider's existing funding mechanisms and the ability of these and possible new mechanisms to fund the development of each public facility project or system. These funding mechanisms may also be described in terms of general guidelines or local policies.

(2) Anticipated financing provisions are not considered land use decisions as specified in ORS 197.712 (Commission duties)(2)(e) and, therefore, cannot be the basis of appeal under ORS 197.610 (Submission of proposed comprehensive plan or land use regulation changes to Department of Land Conservation and Development)(1) and (2) or 197.835 (Scope of review)(4).

Finding:
The Stormwater Master Plan includes information about the proposed location of specific capital projects. The Plan also includes cost estimates, including SDC eligible costs associated with the separate projects. The Plan includes additional discussion of funding mechanisms. These standards are met.

Rule 660-011-0040
Date of Submittal of Public Facility Plans
The public facility plan shall be completed, adopted, and submitted by the time of the responsible jurisdiction's periodic review. The public facility plan shall be reviewed under OAR chapter 660, division 25, "Periodic Review" with the jurisdiction's comprehensive plan and land use regulations. Portions of public facility plans adopted as part of comprehensive plans prior to the responsible jurisdiction's periodic review will be reviewed pursuant to OAR chapter 660, division 18, "Post Acknowledgment Procedures."

Rule 660-011-0045
Adoption and Amendment Procedures for Public Facility Plans

(1) The governing body of the city or county responsible for development of the public facility plan shall adopt the plan as a supporting document to the jurisdiction's comprehensive plan and shall also adopt as part of the comprehensive plan:
(a) The list of public facility project titles, excluding (if the jurisdiction so chooses) the descriptions or specifications of those projects;
(b) A map or written description of the public facility projects' locations or service areas as specified in sections (2) and (3) of this rule; and
(c) The policy(ies) or urban growth management agreement designating the provider of each public facility system. If there is more than one provider with the authority to provide the system within the area covered by the public facility plan, then the provider of each project shall be designated.

(2) Certain public facility project descriptions, location or service area designations will necessarily change as a result of subsequent design studies, capital improvement programs, environmental impact studies, and changes in potential sources of funding. It is not the intent of this division to:
(a) Either prohibit projects not included in the public facility plans for which unanticipated funding has been obtained;

(b) Preclude project specification and location decisions made according to the National Environmental Policy Act; or
(c) Subject administrative and technical changes to the facility plan to ORS 197.610 (Submission of proposed comprehensive plan or land use regulation changes to Department of Land Conservation and Development)(1) and (2) or 197.835 (Scope of review)(4).

(3) The public facility plan may allow for the following modifications to projects without amendment to the public facility plan:
(a) Administrative changes are those modifications to a public facility project which are minor in nature and do not significantly impact the project's general description, location, sizing, capacity, or other general characteristic of the project;
(b) Technical and environmental changes are those modifications to a public facility project which are made pursuant to "final engineering" on a project or those that result from the findings of an Environmental Assessment or Environmental Impact Statement conducted under regulations implementing the procedural provisions of the National Environmental Policy Act of 1969 (40 CFR Parts 1500–1508) or any federal or State of Oregon agency project development regulations consistent with that Act and its regulations.
(c) Public facility project changes made pursuant to subsection (3)(b) of this rule are subject to the administrative procedures and review and appeal provisions of the regulations controlling the study (40 CFR Parts 1500–1508 or similar regulations) and are not subject to the administrative procedures or review or appeal provisions of ORS Chapter 197 (Comprehensive Land Use Planning), or OAR chapter 660 division 18.
(4) Land use amendments are those modifications or amendments to the list, location or provider of, public facility projects, which significantly impact a public facility project identified in the comprehensive plan and which do not qualify under subsection (3)(a) or (b) of this rule. Amendments made pursuant to this subsection are subject to the administrative procedures and review and appeal provisions accorded "land use decisions" in ORS Chapter 197 (Comprehensive Land Use Planning) and those set forth in OAR chapter 660 division 18.

Finding:
The proposed Stormwater Master Plan modifies the existing Public Facilities component of Tualatin's acknowledged Comprehensive Plan. Consistency with urban growth management policies is considered in Section C detailing consistency with applicable Metro Code. The proposed amendments are consistent with these standards.

Rule 660-011-0050
Standards for Review by the Department
The Department of Land Conservation and Development shall evaluate the following, as further defined in this division, when reviewing public facility plans submitted under this division:
(1)Those items as specified in OAR 660-011-0010 (The Public Facility Plan)(1);
(2) Whether the plan contains a copy of all agreements required under OAR 660-011-0010 (The Public Facility Plan) and 660-011-0015 (Responsibility for Public Facility Plan Preparation); and
(3) Whether the public facility plan is consistent with the acknowledged comprehensive plan.

Finding:

As discussed above, the proposed amendments to adopt the Stormwater Master Plan (2019) broaden the extent to which the Public Facilities component of the Comprehensive Plan contains current information consistent with the requirements of OAR 660-011-0010. The City of Tualatin works in close partnership with Clean Water Services in implementing stormwater management practices as is further documented with this plan. Consistency with the acknowledged comprehensive plan is further discussed

C. The following Chapter and Titles of Metro Code are applicable to the proposed amendments:

Title 3: Water Quality and Flood Management

3.07.310 Intent

To protect the beneficial water uses and functions and values of resources within the Water Quality and Flood Management Areas by limiting or mitigating the impact on these areas from development activities and protecting life and property from dangers associated with flooding. [Ord. 97-715B, Sec. 1. Ord. 98-730C, Sec. 1. Ord. 00-839, Sec. 1. Ord. 05- 1077C, Sec. 6.]

3.07.320 Applicability

(a) Title 3 applies to:

(1) Development in Water Quality Resource and Flood Management Areas.

(2) Development which may cause temporary or permanent erosion on any property within the Metro Boundary.

(b) Title 3 does not apply to work necessary to protect, repair, maintain, or replace existing structures, utility facilities, roadways, driveways, accessory uses and exterior improvements in response to emergencies provided that after the emergency has passed, adverse impacts are mitigated in accordance with the performance standards in Section 3.07.340. [Ord. 97-715B, Sec. 1. Ord. 98-730C, Sec. 1. Ord. 00-839, Sec. 1. Ord. 02-972A, Sec. 1. Ord. 05-1077C, Sec. 6.]

3.07.330 Implementation Alternatives for Cities and Counties

(a) Cities and counties shall comply with this title in one of the following ways:

(1) Amend their comprehensive plans and implementing ordinances to adopt all or part of the Title 3 Model Ordinance or code language that substantially complies with the performance standards in Section 3.07.340 and the intent of this title, and adopt either the Metro Water Quality and Flood Management Area Map or a map which substantially complies with the Metro map. Cities and counties may choose one of the following options for applying this section:

(A) Adopt code language implementing this title which prevails over the map and uses the map as reference; or

(B) Adopt a city or county field verified map of Water Quality and Flood Management Areas based on the Metro Water Quality and Flood Management map implementing this title which prevails over adopted code language. Field verification is a process of identifying or delineating Protected Water Features, Water Quality Resource Areas and Flood Management Areas shown on the Metro Water Quality and Flood Management Areas map. This process includes examination of information such as site visit reports, wetlands inventory maps, aerial photographs, and public

input and review. The field verification process shall result in a locally adopted Water Quality and Flood Management Areas map which:

(i) Applies the Title 10 definitions of Protected Water Feature, Water Quality Resource Areas and Flood Management Areas to all those protected areas on the Metro Water Quality and Flood Management Areas map to show the specific boundaries of those protected areas on the locally adopted Water Quality and Flood Management Areas map; and

(ii) Is subject to amendment by applying adopted code language to add Protected Water Features, Water Quality Resource Areas and Flood Management Areas and to correct errors in the local Water Quality and Flood Management Areas map consistent with Section 3.07.330(d).

(2) Demonstrate that existing city and county comprehensive plans and implementing ordinances substantially comply with the performance standards in Section 3.07.340 and the intent of this title.

(3) Any combination of (1) and (2) above that substantially complies with all performance standards in Section 3.07.340.

(b) Cities and counties shall hold at least one public hearing prior to adopting comprehensive plan amendments, ordinances and maps implementing the performance standards in Section 3.07.340 of this title or demonstrating that existing city or county comprehensive plans and implementing ordinances substantially comply with Section 3.07.340, to add Protected Water Features, and wetlands which meet the criteria in Section 3.07.340(e)(3), to their Water Quality and Flood Management Area map. The proposed comprehensive plan amendments, implementing ordinances and maps shall be available for public review at least 45 days prior to the public hearing.

(c) Cities and counties shall conduct a review of their Water Quality and Flood Management Areas map concurrent with local periodic review required by ORS 197.629.

(d) Some areas which would otherwise be mapped as Protected Water Features, Water Quality Resource Areas and Flood Management Areas do not appear on the Metro Water Quality and Flood Management Areas map because streams had been culverted, wetlands had been filled or a fill permit had been approved, or the area was demonstrated to have existing conflicting water dependent uses, or existing plans or agreements for such uses, or the area was developed or committed to other uses. Notwithstanding any other provision of this title, cities and counties are not required to establish Protected Water Features, Water Quality Resource Areas and Flood Management Areas through adopted code provisions or mapping for areas which were examined but not included on the Water Quality and Flood Management Areas map adopted by the Metro Council. [Ord. 97-715B, Sec. 1. Ord. 98-730C, Sec. 1. Ord. 00-839, Sec. 1. Ord. 02-972A, Sec. 1. Ord. 15-1357.]

3.07.340 Performance Standards

(a) Flood Management Performance Standards.

(1) The purpose of these standards is to reduce the risk of flooding, prevent or reduce risk to human life and property, and maintain functions and values of floodplains such as allowing for the storage and conveyance of stream flows through existing and natural flood conveyance systems.

(2) All development, excavation and fill in the Flood Management Areas shall conform to the following performance standards:

(A) Development, excavation and fill shall be performed in a manner to maintain or increase flood storage and conveyance capacity and not increase design flood elevations.

(B) All fill placed at or below the design flood elevation in Flood Management Areas shall be balanced with at least an equal amount of soil material removal.

(C) Excavation shall not be counted as compensating for fill if such areas will be filled with water in non-storm winter conditions.

(D) Minimum finished floor elevations for new habitable structures in the Flood Management Areas shall be at least one foot above the design flood elevation.

(E) Temporary fills permitted during construction shall be removed.

(F) Uncontained areas of hazardous materials as defined by DEQ in the Flood Management Area shall be prohibited.

(3) The following uses and activities are not subject to the requirements of subsection(2):

(A) Excavation and fill necessary to plant new trees or vegetation.

(B) Excavation and fill required for the construction of detention facilities or structures, and other facilities such as levees specifically designed to reduce or mitigate flood impacts. Levees shall not be used to create vacant buildable lands.

(C) New culverts, stream crossings, and transportation projects may be permitted if designed as balanced cut and fill projects or designed to not significantly raise the design flood elevation. Such projects shall be designed to minimize the area of fill in Flood Management Areas and to minimize erosive velocities. Stream crossing shall be as close to perpendicular to the stream as practicable. Bridges shall be used instead of culverts wherever practicable.

(b) Water Quality Performance Standards.

(1) The purpose of these standards is to: 1) protect and improve water quality to support the designated beneficial water uses as defined in Title 10, and 2) protect the functions and values of the Water Quality Resource Area which include, but are not limited to:

(A) Providing a vegetated corridor to separate Protected Water Features from development;

(B) Maintaining or reducing stream temperatures;

(C) Maintaining natural stream corridors;

(D) Minimizing erosion, nutrient and pollutant loading into water;

(E) Filtering, infiltration and natural water purification; and

(F) Stabilizing slopes to prevent landslides contributing to sedimentation of water features.

(2) Local codes shall require all development in Water Quality Resource Areas to conform to the following performance standards:

(A) The Water Quality Resource Area is the vegetated corridor and the Protected Water Feature. The width of the vegetated corridor is specified in Table 3.07-3. At least three slope measurements along the water feature, at no more than 100-foot increments, shall be made for each property for which development is proposed. Depending on the width of the property, the width of the vegetated corridor will vary.

(B) Water Quality Resource Areas shall be protected, maintained, enhanced or restored as specified in Section 3.07.340(b)(2).

(C) Prohibit development that will have a significant negative impact on the functions and values of the Water Quality Resource Area, which cannot be mitigated in accordance with subsection (2)(F).

(D) Native vegetation shall be maintained, enhanced or restored, if disturbed, in the Water Quality Resource Area. Invasive nonnative or noxious vegetation may be removed from the Water Quality Resource Area. Use of native vegetation shall be encouraged to enhance or restore the Water Quality Resource Area. This shall not preclude construction of energy dissipaters at outfalls consistent with watershed enhancement, and as approved by local surface water management agencies.

(E) Uncontained areas of hazardous materials as defined by DEQ in the Water Quality Resource Area shall be prohibited.

(F) Cities and counties may allow development in Water Quality Resource Areas provided that the governing body, or its designate, implement procedures which: (i) Demonstrate that no practicable alternatives to the requested development exist which will not disturb the Water Quality Resource Area; and (ii) If there is no practicable alternative, limit the development to reduce the impact associated with the proposed use; and (iii) Where the development occurs, require mitigation to ensure that the functions and values of the Water Quality Resource Area are restored.

(G) Cities and counties may allow development for repair, replacement or improvement of utility facilities so long as the Water Quality Resource Area is restored consistent with Section 3.07.340(b)(2)(D).

(H) The performance standards of Section 3.07.340(b)(2) do not apply to routine repair and maintenance of existing structures, roadways, driveways, utilities, accessory uses and other development.

(3) For lots or parcels which are fully or predominantly within the Water Quality Resource Area and are demonstrated to be unbuildable by the vegetative corridor regulations, cities and counties shall reduce or remove vegetative corridor regulations to assure the lot or parcel will be buildable while still providing the maximum vegetated corridor practicable. Cities and counties shall encourage landowners to voluntarily protect these areas through various means, such as conservation easements and incentive programs.

(c) Erosion and Sediment Control.

(1) The purpose of this section is to require erosion prevention measures and sediment control practices during and after construction to prevent the discharge of sediments.

(2) Erosion prevention techniques shall be designed to prevent visible and measurable erosion as defined in Title 10.

(3) To the extent erosion cannot be completely prevented, sediment control measures shall be designed to capture, and retain on-site, soil particles that have become dislodged by erosion.

(d) Implementation Tools to Protect Water Quality and Flood Management Areas.

(1) Cities and counties shall either adopt land use regulations, which authorize transfer of permitted units and floor area to mitigate the effects of development restrictions in Water Quality and Flood Management Areas, or adopt other measures that mitigate the effects of development restrictions.

(2) Metro encourages local governments to require that approvals of applications for partitions, subdivisions and design review actions be conditioned upon one of the following:

(A) Protection of Water Quality and Flood Management Areas with a conservation easement;

(B) Platting Water Quality and Flood Management Areas as common open space; or

(C) Offer of sale or donation of property to public agencies or private non-profits for preservation where feasible.

(3) Additions, alterations, rehabilitation or replacement of existing structures, roadways, driveways, accessory uses and development in the Water Quality and Flood Management Area may be allowed provided that:

(A) The addition, alteration, rehabilitation or replacement is not inconsistent with applicable city and county regulations, and

(B) The addition, alteration, rehabilitation or replacement does not encroach closer to the Protected Water Feature than the existing structures, roadways, driveways or accessory uses and development, and

(C) The addition, alteration, rehabilitation or replacement satisfies Section 3.07.340(c) of this title.

(D) In determining appropriate conditions of approval, the affected city or county shall require the applicant to:

(i) Demonstrate that no reasonably practicable alternative design or method of development exists that would have a lesser impact on the Water Quality Resource Area than the one proposed; and

(ii) If no such reasonably practicable alternative design or method of development exists, the project should be conditioned to limit its disturbance and impact on the Water Quality Resource to the minimum extent necessary to achieve the proposed addition, alteration, restoration, replacement or rehabilitation; and

(iii) Provide mitigation to ensure that impacts to the functions and values of the Water Quality Resource Area will be mitigated or restored to the extent practicable.

(4) Cities and counties may choose not to apply the Water Quality and Flood Management Area performance standards of Section 3.07.340 to development necessary for the placement of structures when it does not require a grading or building permit.

(5) Metro encourages cities and counties to provide for restoration and enhancement of degraded Water Quality Resource Areas through conditions of approval when development is proposed, or through incentives or other means.

(6) Cities and counties shall apply the performance standards of this title to Title 3 Wetlands as shown on the Metro Water Quality and Flood Management Areas Map and locally adopted Water Quality and Flood Management Areas maps. Cities and counties may also apply the performance standards of this title to other wetlands.

(e) Map Administration. Cities and counties shall amend their comprehensive plans and implementing ordinances to provide a process for each of the following:

(1) Amendments to city and county adopted Water Quality and Flood Management Area maps to correct the location of Protected Water Features, Water Quality Resource Areas and Flood Management Areas. Amendments shall be initiated within 90 days of the date the city or county receives information establishing a possible map error.

(2) Modification of the Water Quality Resource Area upon demonstration that the modification will offer the same or better protection of water quality, the Water Quality and Flood Management Area and Protected Water Feature.

(3) Amendments to city and county adopted Water Quality and Flood Management Area maps to add Title 3 Wetlands when the city or county receives significant evidence that a wetland meets any one of the following criteria:

(A) The wetland is fed by surface flows, sheet flows or precipitation, and has evidence of flooding during the growing season, and has 60 percent or greater vegetated cover, and is over one-half acre in size; or The wetland qualifies as having "intact water quality function" under the 1996 Oregon Freshwater Wetland Assessment Methodology; or

(B) The wetland is in the Flood Management Area, and has evidence of flooding during the growing season, and is five acres or more in size, and has a restricted outlet or no outlet; or The wetland qualifies as having "intact hydrologic control function" under the 1996 Oregon Freshwater Wetland Assessment Methodology; or

(C) The wetland or a portion of the wetland is within a horizontal distance of less than one-fourth mile from a water body which meets the Department of Environmental Quality definition of "water quality limited" water body in OAR Chapter 340, Division 41. Examples of significant evidence that a wetland exists that may meet the criteria above are a wetland assessment conducted using the 1996 Oregon Freshwater Wetland Assessment Methodology, or correspondence from the Division of State Lands that a wetland determination or delineation has been submitted or completed for property in the city or county.

(4) Cities and counties are not required to apply the criteria in Section 3.07.340(e)(3) to water quality or stormwater detention facilities. [Ord. 97-715B, Sec. 1. Ord. 98-730C, Sec. 1. Ord. 00-839, Sec. 1. Ord. 02-972A, Sec. 1. Ord. 05- 1077C, Sec. 6. Ord. 15-1357.]

3.07.360 Metro Model Ordinance Required

Metro shall adopt a Water Quality and Flood Management Areas Model Ordinance and map. The Model Ordinance shall represent one method of complying with this title. The Model Ordinance shall be advisory, and cities and counties are not required to adopt the Model Ordinance, or any part thereof, to substantially comply with this title. However, cities and counties which adopt the Model Ordinance in its entirety and a Water Quality and Flood Management Areas Map shall be deemed to have substantially complied with the requirements of this title. [Ord. 97-715B, Sec. 1. Ord. 98-730C, Sec. 2. Ord. 00-839, Sec. 1. Ord. 05-1077C, Sec. 6.)

[…]

Finding:

Compliance with Title 3 is administered in Tualatin by Clean Water Services. Future development in Tualatin will be comply with Clean Water Services' Design and Construction Standards & Service Provider Letters (SPLs) requirements. Sensitive areas such as vegetated corridors surrounding streams and wetland habitat are identified, protected and maintained by Clean Water Services. The proposed amendments are consistent with Title 3.

D. The following Chapters of the Tualatin Comprehensive Plan are applicable to the proposed amendments:

Chapter 9---Public Facilities and Services

Finding:

The adoption of the Stormwater Master Plan (2019) and updated policies is largely relevant to Chapter 9—Public Facilities and Services, which is in turn updated by the plan. The range of proposed amendments remains consistent with the *Goal 9.3, to provide a plan for routing surface drainage through the City, utilizing natural drainages when possible. Update the plan as needed with drainage studies of problem areas and to respond to changes in the drainage pattern caused by urban development.* The proposed Master Plan inherently poses an update to the existing plan with updated data reflecting the present development patterns and addressing problem areas, and provides a plan for managing stormwater flows.

Specific policies are updated to reflect current data as studied in the Stormwater Master Plan and reflect current administrative practices and partnerships. Other than where it is appropriate to update said Comprehensive Plan policies, the changes remain consistent with the Comprehensive Plan.

E. The following Chapters of the Tualatin Development Code are applicable to the proposed amendments:

Chapter 33: Applications and Approval Criteria

Section 33.070 Plan Amendments

[…]

(2) Applicability. Quasi-judicial amendments may be initiated by the City Council, the City staff, or by a property owner or person authorized in writing by the property owner. Legislative amendments may only be initiated by the City Council.

<u>Finding:</u>
A Plan Text Amendment and Plan Map Amendment are proposed. This proposal is legislative in nature and therefore has been processed consistent with the Type IV-B procedures in Chapter 32. This criterion is met.

[…]

(5) Approval Criteria.

a.) Granting the amendment is in the public interest.

b.) The public interest is best protected by granting the amendment at this time.

<u>Finding:</u>

The amendment would adopt and implement the Stormwater Master Plan. In order to ensure that the Tualatin Development Code accurately reflects the current Sewer Master Plan for future implementation, it is necessary to update the corresponding maps and text contained therein.

Without these updates, the development of important infrastructure could be stymied. A functioning sewer system is in the interest of public health, safety, and local prosperity. This amendment is also timely, given that Council has already adopted the Sewer Master Plan and directed staff to further implement its contents through the Comprehensive Plan. Criteria (a) and (b) are met.

c.) The proposed amendment is in conformity with the applicable objectives of the Tualatin Comprehensive Plan.

The applicable goals and policies of the Tualatin Comprehensive Plan have been considered, and are discussed above in Section D. Criterion (c) is met.

d.) The following factors were consciously considered:

- **i. The various characteristics of areas in the City.**
- **ii. The suitability of the area for particular land uses and improvements.**
- **iii. Trends in land improvement and development.**
- **iv. Property values.**
- **v. The needs of economic enterprises and the future development of the area; needed right-of-way and access for and to particular sites in the area;**
- **vi. Natural resources of the City and the protection and conservation of said resources.**
- **vii. Prospective requirements for the development of natural resources in the City.**
- **viii. The public need for healthful, safe, aesthetic surroundings and conditions.**
- **ix. Proof of change in a neighborhood or area, or a mistake in the Plan Text or Plan Map for the property under consideration are additional relevant factors to consider.**

Finding:

The proposed amendments to the plan text do not change any land use designation or zoning, and do not have a direct impact on the mix of allowed uses. A functioning stormwater management system is however important to supporting citywide development potential and property value. The Stormwater Master Plan proposes a coordinated approach to managing infrastructure improvements that will be needed to support new development in Tualatin, preserve development, and allow for daily activities such as transportation to continue in a healthy and safe manner. Furthermore, a functioning stormwater management system is critical to protecting natural resources, limiting the extent to which pollutants enter waterways.

Criterion (d) is met.

e.) If the amendment involves residential uses, then the appropriate school district or districts must be able to reasonably accommodate additional residential capacity by means determined by any affected school district.

Finding:

The amendment does not involve residential uses. Criterion (e) does not apply.

f.) Granting the amendment is consistent with the applicable State of Oregon Planning Goals and applicable Oregon Administrative Rules, including compliance with the Transportation Planning Rule TPR (OAR 660-012-0060).

Finding:

Section C details findings for the Oregon Planning Rules. Criterion (f) is met.

g.) Granting the amendment is consistent with the Metropolitan Service District's Urban Growth Management Functional Plan.

Finding:

The amendments to Chapters 1 and 9 of the Comprehensive Plan do not affect any portion of the Urban Growth Functional Management Plan. Criterion (g) is met.

h.) Granting the amendment is consistent with Level of Service F for the p.m. peak hour and E for the one-half hour before and after the p.m. peak hour for the Town Center 2040 Design Type (TDC Map 9-4), and E/E for the rest of the 2040 Design Types in the City's planning area.

Finding:

Amendments to Chapters 1 and 9 of the Comprehensive Plan are not anticipated to add automobile traffic. Criteria (h) is met.

i.) Granting the amendment is consistent with the objectives and policies regarding potable water, sanitary sewer, and surface water management pursuant to TDC 12.020, water management issues are adequately addressed during development or redevelopment anticipated to follow the granting of a plan amendment.

Finding:
The amendments have implications for surface water management, which are discussed in Section B. Criterion (i) is met.

j.) The applicant has entered into a development agreement. This criterion applies only to an amendment specific to property within the Urban Planning Area (UPA), also known as the Planning Area Boundary (PAB), as defined in both the Urban Growth Management Agreement (UGMA) with Clackamas County and the Urban Planning Area Agreement (UPAA) with Washington County. TDC Map 9-1 illustrates this area.

Finding:
The proposed amendments are not property specific and this criterion does not apply.

III. RECOMMENDATION

Based on the application and the above analysis and findings, the proposed annexation complies with applicable Oregon Administration Rules, Metro Code, and TDC. Accordingly, staff recommends City Council approval of File No. PTA 21-0001.

From: Hayden Ausland
Sent: Thursday, December 10, 2020 10:58 AM
To: 'grluci@gmail.com'; Kim McMillan
Cc: 'JWLuci@gmail.com'; Tabitha Boschetti; Steve Koper
Subject: RE: Stormwater Master Plan - Public Comment Period

Hi Grace,

I'm certainly not the expert when it comes to Planning Commission or City Council Meetings, so I've reached out to a coworker (Tabitha) for some clarification on this and have also Cc'd her with this email in case I muck anything up.

The City Council meeting would be a public hearing with a formal opportunity for verbal testimony at the hearing, and/or written testimony. Anyone can testify. The packet of materials going to Council is published one week before the hearing. We would let you know ahead of time which Council Meeting the Stormwater Master Plan will be on the agenda. The specific date for the Planning Commission and the City Council meetings have not yet been set for approval of this document. Once these dates are confirmed, we would be happy to let you know.

The Planning Commission meeting would not be a formal hearing. The Planning Commission reviews proposed Plan Text Amendments in their role as an advisory body and can choose to make a recommendation to City Council. There is still a more general opportunity for members of the public to share comments with the Planning Commission during this meeting.

Although community members may provide comments and feedback during these meetings, it should be noted that the Stormwater Master Plan will be presented for adoption in its **Final Draft** form. Right now is probably the best opportunity to provide feedback and comments on the Stormwater Master Plan.

Although Kim is the new the Community Development Director, she is also continuing her role as the City Engineer (which us engineers are very happy about ☺).

Regards,

Hayden Ausland, EIT, CPSWQ
Engineering Associate - Water Quality
City of Tualatin
P 503.691.3037 | **C** 971.978.8217

From: G Lucini <grluci@gmail.com>
Sent: Monday, December 7, 2020 3:43 PM
To: Hayden Ausland <hausland@tualatin.gov>; Kim McMillan <kmcmillan@tualatin.gov>
Cc: John Lucini <JWLuci@gmail.com>
Subject: Re: Stormwater Master Plan - Public Comment Period

Hi Hayden,

I have a couple of quick questions as to how the City's proposed Stormwater Master Plan Update will be handled with regards to the role of Citizens and Citizen Input/Comments during the Plan Update process. We have had a few issues in the past years, and do appreciate your emails informing us of the ability to submit Citizen Comments on this Master Plan Update.

We want to gain a better understanding as to the City's process -and the role and actions Citizens may take to keep informed and participate in the Stormwater Management Master Plan Update.

I understand the City is providing a Citizen Comment period ending December 15th.
And I understand the proposed Master Plan will then be presented to the Planning Commission, and then to the City Council for adoption into the City's governing documents.

Questions:
1) Will Citizens be provided opportunities for additional Citizen Comments during those two Public Meetings (Planning Commission and/or City Council), as well as during this Comment Period ending on Dec 15th?

2) Should the City make revisions to the proposed plan currently being presented to the Public for comment--- will Citizens who provided Comments on the proposed Master Plan Update Citizen Comment Period ending 12-15-2020---be informed of changes or revisions (Major or minor) made to the proposed Update?

> **And will those Citizens who provided comment be provided reasonable advanced access and information as to any changes which may occur after December 15th---- and prior to the next Public Meeting where any proposed changes will be presented?**

3) I understand Kim has had a change in her responsibilities at the City, and was wondering who will be assuming her previous role as City Engineer?

As I have expressed previously, my husband and I would like to receive ***Actual Notice*** **of any Public Meeting/s regarding the proposed changes to the City's Master Plan for Stormwater Management- including but not limited to the City of Tualatin Planning Commission and/or the City of Tualatin City Council.**
As Interested Persons, and potentially affected downstream property owners in the Basalt Creek Area, we are again providing our contact information in order to be provided such a Notice. (ORS 192.640).

As our home and property are located in the Basalt Creek Area, outside the City of Tualatin City Limits, and we may potentially be directly or indirectly impacted by potential changes to the City's proposed update to the Stormwater Master Plan- we again express our appreciation of efforts taken to keep us informed regarding this action under consideration by the City of Tualatin.

Grace Lucini

23677 SW Boones Ferry Road

Tualatin OR 97062
GrLuci@gmail.com

John Lucini
23677 SW Boones Ferry Road
Tualatin OR 97062
JWLuci@gmail.com

Regards,
Grace

On Wed, Dec 2, 2020 at 11:07 AM G. Lucini <grluci@gmail.com> wrote:

> Thank you Hayden!
> I have skimmed the report.
> Working on putting together my comments when I can do a deeper review.
>
> Hope you and yours are well and having an opportunity to enjoy the holiday season.
> Grace
>
> Sent from my iPhone
>
> On Dec 2, 2020, at 9:59 AM, Hayden Ausland <hausland@tualatin.gov> wrote:
>
> Hi Grace,
>
> I just wanted to let you know that our virtual Stormwater Open House website is now live and the comment period is active. Here is a link to the Open House website: Stormwater Master Plan Virtual Open House.
>
> Regards,
>
> **Hayden Ausland, EIT, CPSWQ**
>
> Engineering Associate - Water Quality

City of Tualatin

P 503.691.3037 | **C** 971.978.8217

From: Hayden Ausland
Sent: Tuesday, November 24, 2020 4:55 PM
To: grluci@gmail.com
Cc: Kim McMillan <kmcmillan@tualatin.gov>; JWLuci@gmail.com
Subject: Stormwater Master Plan - Public Comment Period

Good afternoon Grace,

I wanted to let you know that Tualatin is scheduled to open the period for Public Comment on December 1st for the Stormwater Master Plan. The comment period will be open from Dec 1 through December 15. Once we have the website officially up and running, I will send you another email with a link to that website.

Hope you have an enjoyable Thanksgiving.

Regards,

Hayden Ausland, EIT, CPSWQ

Engineering Associate - Water Quality

City of Tualatin

P 503.691.3037 | **C** 971.978.8217

From: Hayden Ausland
Sent: Tuesday, December 15, 2020 4:32 PM
To: Megan George; Kelsey Lewis
Subject: FW: 2019 Stormwater Master Plan questions and thoughts

FYI,

More Stormwater Master Plan comments and questions.

Regards,

Hayden Ausland, CPSWQ
Engineering Associate - Water Quality
City of Tualatin
P 503.691.3037 | C 971.978.8217

-----Original Message-----
From: Marissa Houlberg <marissa@houlbergdevelopment.com>
Sent: Monday, December 14, 2020 1:57 PM
To: Engineering External Email <engineering@tualatin.gov>
Subject: 2019 Stormwater Master Plan questions and thoughts

Thank you for sharing the document with all and requesting feedback!

This document is dated April 2019 but we are reviewing December 2020. Why over a year to seek feedback when the document was completed early 2019?

There was an updated flood map issued for our area within the last ten years, I believe. Can this be included in the document?

Overview questions are:
I believe our TDC requires lawns in the Industrial/Mfg section of the city. Does it make sense now to not require lawns because of maintenance/herbicide/water issues and instead give guidance to native plantings? Native plantings require no chemicals, less maintenance and water in addition to protecting stream health.

Do most of our trails do double duty? Are some bioswales too? Can we educate Tualatin residents so that more residents are aware of the not so obvious stormwater street and rooftop work these greenways are performing?

I made notes as I read the plan so will write my comments and questions as listed in my notes.

Page x
Single Family LIDA. What is the purpose of this inspection program, what is included and what are the benefits?

Page 2-4; Table2-2

Impervious for Commercial and Industrial is 74% and 78%. Is this percentage high because of parking lots? Some percentages are as low as 43%.

Page 2-4 Basalt Creek planning timeframe is unknown? There is a residential development going in called Autumn Sunrise or a similar type of name. This residential development is not a part of Basalt Creek? There isn't a hydrological assessment for this development?

Page 2-6; Table 2-4 Inventory Pipers & Open Channels Diameter 0 - 72 inches Diameters of 42-72 inches are pipe or open channels? I seem to remember a very large pipe south side, parallel to Tualatin Sherwood Rd. Is this pipe 72 inches? What is the purpose of this pipe?

Water Quality Facility Maintenance, City Wide What does a Water Quality Facility look like? How does a WQ Facility function? What does maintenance require/entail?

Page 4-2; Why are culverts for Open Channel and ditch (potential road washout) designed for 100 year peak flow? Most appear to be designed for 2 & 10 year flooding. How often are our peak 100 year flows happening; seem like twenty-thirty year frequency?

Page 4-7 Warm Springs, Tonka existing pipes and open channels are undersized.
Can parking areas with pervious surfaces help lower flood occurrences?

How is a creek privately owned? Is it because the landowner owns the land on one or both sides and the creek is included? Is the creek itself owned by the Wetlands Conservancy and not the surrounding land? Considering creeks and rivers extend their boundaries during high water flow does creek ownership extend to the land on either side to accommodate the overflow?

Page 5-3; Table 5-1 Contributing existing Impervious (%) for Saum, Nyberg and Hedges Creeks I noted a 10% jump for contributing 'future' impervious - How do we keep the future number closer to 0%?

Page 6-3; Table 6-2
Contract landscape at 72 sites $108,300 How much maintenance is mowing? Can we replace flat areas with natives not requiring mowing?

Page 6-5, 6-6 Clearing trees
Seqouia Ridge, Sweet Drive Pond
What type of trees need to be cleared? Why? Isn't our goal to shade our watersheds and lower in stream water temperature?

Page 7-10 Stream Vegetation Mgmt.
Cost assumptions based on removing .5 acres of invasive vegetation per year at a unit cost $4.60/sq. ft.; $100,000 per year.
Can local volunteers assist in some of the smaller sites to remove invasives? Not just coordinated, one day removal but possible neighborhood project worked on over a more lax/when they want schedule, greater period of time with what needs to be removed and objectives defined? If residents knew how

much they were saving the city and themselves by doing the work perhaps those numbers would be motivational?

Thank you so much for reading!

Marissa

Submission #3

Previous submission Next submission

Print

Submission information

Form: Stormwater Master Plan Comment Form
Submitted by Visitor (not verified)
Tue, 12/15/2020 - 10:37am
50.126.107.254

Name

Marissa Houlberg

Email Address

marissa@houlbergdevelopment.com

Comment/Question *

I sent an email yesterday with a list of comments and questions. I truly appreciate being able to read and submit question on the Master Plan. I look forward to being educated on stormwater treatment and control.

Please provide comments and questions about the Tualatin Stormwater Master Plan for consideration before the plan goes to the Planning Commission and City Council for adoption.

What is your relationship with Tualatin? *

- [x] Live in Tualatin
- [x] Work in Tualatin
- [ ] Neither

Save

Previous submission Next submission

12-15-2020

For Public Record- Proposed Update to City of Tualatin Stormwater Management Master Plan

To: The City of Tualatin Department of Engineering

Cc: Members of the Tualatin City Council and City of Tualatin City Council
City of Tualatin Planning Commission

RE: **Proposed Update to City of Tualatin Stormwater Management Master Plan**

My husband and I appreciate the opportunity to provide Citizen Comments on this first opportunity for Public access and Comment Period on the proposed update to the City of Tualatin's Stormwater Management Master Plan being undertaken by the City. We support the efforts of the City to acknowledge and attempt to respond to the various changes and philosophies regarding Stormwater Management which have occurred since the current Master Plan was adopted several years ago.

We also recognize the City of Tualatin has undergone various changes since the City's Stormwater Master Plan was adopted in 1972. It would be expected the scope of the Land Use Master Plan would include all lands within the City limits- as well as lands identified within the future jurisdiction of the City- and assessment, analysis and stormwater management planning would be applied to all the lands within the scope of the project for both current and future needs.

The need for coordination of Land Use Planning between overlapping governments is necessary and mandated. As the northern portion of the Basalt Creek Area is identified as under the future jurisdiction of the City of Tualatin, and the City has already started the urbanization process, it is important for the City of Tualatin to identify a method for ensuring the effective coordination of Land Use Planning with other local governments- especially those with overlapping jurisdictions or responsibilities. The majority of the Basalt Creek Drainage flows south eventually through the City of Wilsonville and into the Willamette River. Very little of Stormwater drainage from the Basalt Creek Area flows north into the City's existing catchment and conveyance system.

Since Washington County currently has ownership and jurisdiction over the existing stormwater system within the Basalt Creek Area, and the County's stormwater conveyance and treatment systems are within lands under various ownerships, it is important for the City provide a well-crafted Stormwater Management Plan for the Basalt Creek Area.

The City already acknowledged in the Basalt Creek Concept Plan of the potential need to upgrade the existing stormwater system within the Basalt Creek Area to accommodate future development within the Area.

Neither my husband nor I are against development.

As citizens and residents of the Basalt Creek Area the ability to participate in this first solicitation for input/feedback by potentially affected Citizens on this proposed update to a City's Land Use Plan is welcomed. We are particularly interested in the creation of a well written fact-based Update to the City's Stormwater Management Master Plan, as our home and property is within the Basalt Creek Area –in an area which the City has future jurisdiction, and downstream from lands recently annexed into the City and are coming under consideration for development.

> As potentially affected Citizens and property owners within unincorporated Washington County, my husband and I have for many years attempted to work with both the City of Tualatin and with Washington County in recognizing and addressing our concerns regarding Stormwater Management within the Basalt Creek Area.

We have presented our concerns as to the need for a fact-based Stormwater Management Plan for the Basalt Creek Area for use as part of Land Use Planning Actions within the area. We have submitted these concerns numerous times, to the staff of the Cities of Tualatin and Wilsonville, to the City of Tualatin Planning Commission, and to the Tualatin City Council including:

- during the development of the Basalt Creek Concept Plan by the Cities of Tualatin and Wilsonville (2012-2018)
- written fact-based testimonies to the City of Tualatin during the City Council 2019 Hearings on the Basalt Creek Comprehensive Plan proposed adoption and integration into the City's governing documents as to the need for further- identification and documentation of Natural Resources, and the need for a Stormwater Plan --to specifically access and address the current and future needs within the scope of the lands to be included within the Comprehensive Plan
- on 3-21-2020 my husband and I submitted written testimony to the Tualatin City Council, again supported by documentation, as to the lack of pertinent facts and information on Land Use Planning for the Public Service of Stormwater Management relating to the application for annexation of 40+acres of lands within the Basalt Creek Area into the City of Tualatin.

My husband and I now present our concerns regarding the proposed Stormwater Management planning within the Basalt Creek Area as presented within the proposed Master Plan Update to the City of Tualatin, the City of Tualatin Planning Commission, and to the City of Tualatin City Council.

This is first opportunity provided by the City for Citizen review and comment on the proposed Update to the City's Stormwater Master Plan.

We note there are inconsistent, conflicting or omitted information between the proposed Update and the City's existing Governing Documents. The lack of relevant, accurate, consistent and necessary information between the proposed Stormwater Master Plan and many of the City's current documents may result in difficulties in the safe effective implementation of Stormwater Management by the City and coordination of Land Use Planning with other governmental units.

Recognizing that my husband and I do not have a professional working knowledge of Stormwater Management or hydraulic dynamics, we have obtained the services of Dave La Liberte, Principal Engineer of Liberte Environmental Associates to review and comment upon the technical aspects of the proposed Update to the City's Master Plan. David M. LaLiberte, P.E., Civil and Environmental Engineer is licensed in the State of Oregon, has compiled these comments under contract with us. Mr. La Liberte' has over 30 years of experience in stormwater, water quality and design solution analysis. His Cumuli Vitae (CV) identifying his education and experience are attached as (Attachment #1 Supplement C). He has personally conducted various hydrodynamic modeling scenarios within the Basalt Creek Area. We believe Mr. La Liberte to be highly qualified to provide relevant comments upon the proposed Update to the City of Tualatin Stormwater Management Master Plan (SWMP).

Mr. La Liberte's comments regarding the City's proposed Update to the SWMP are to be considered a part of our Citizen Comments and are attached.

Also included as an embedded Google Link are additional documents including studies and analysis conducted by Mr. La Liberte' in 2016, ***"Effects of SW Boones Ferry Road Construction (2013-2015) Stormflow Analysis for the Lucini Property Washington County, Oregon"*****.**

To offer identification of issues and assistance in a Land Use planning action – allowing the City of Tualatin to gain future jurisdiction over the northern portion of the Basalt Creek Area--this Stormflow Analysis was submitted to the Cities of Tualatin and Wilsonville during the Basalt Creek Concept Planning process. This study has also been provided to the City of Tualatin staff on other subsequent occasions.

SEE EMAIL ATTACHMENT --LA LIBERTE' ENVORONMENTAL ATTACHMENTS #1, #2 & #3 (INCLUDES SUPPLEMENTS)

TECHNICAL COMMENTS RELATING PROPOSED UPDATE TO THE CITY'S MASTER PLAN (Summarization)

A summarization of Review of Document Comments
by Mr. La Liberte, Principle Engineer La Liberte' Environmental Associates:

Significant problems in the Plan for the BFR south area are:

- lack of identified stormwater facilities
- omission of hydrologic and hydraulic modeling analysis
- potential for misapplication of design alternatives
- absence of stormwater problem acknowledgement and evaluation
- no assessment of stormflows on steep slopes
- topography and soils suggest that infiltration is not a likely future runoff design solution in the Boones Ferry Road area
  - This is an important issue as to the elevation of lands, steep slopes, and drainage into Basalt Creek
  - The elevation of lands above the drinking water wells is of concern with impact upon the well from which the Lucini's obtain their water
- effect of stormflows on the Basalt Creek Concept Plan are neglected
- no existing and future development stormwater flows are compared
- protection of natural resources is unclear
- no designation of Capital Improvement Projects (CIPs9) in the BFR south area
- There is no assessment of peak and average stormflows on the steep slopes, which constitute the west flank of the BFR south area
  - These Tualatin stormflows discharge to the Basalt Creek Concept Plan area and their existence is not established in the SWMP.
  - Stormflows on these steep slopes have excessive peak and average flow velocities, which cause erosion
    SEE: Supplement B Part 1 Analysis Report Section 4.
    Stormflow Hydraulics and Part 2 Appendices A2 and I
- The Tualatin SWMP makes no provisions for temporary stormwater storage and discharge facilities when phasing-in large developments such as the Autumn Sunrise property in BFR south.
  - The concern is that arbitrary storage and discharge locations could occur in the interim, before the final stormwater facility is operable.
  - It needs to be specified in the Tualatin SWMP that new construction developments must use stormwater facilities and outfalls consistent only with its final specifications and drawings.

ADDITIONAL COMMENTS -MAPS WITHIN PROPOSED UPDATE TO THE CITY'S MASTER PLAN

PROPOSED MAPS:

- CONTAIN DATED INFORMATION
- OMISSION OF RELAVENT AND NESSARY INFORMATION REQUIRED FOR LAND USE PLANNING

SEE EMAIL ATTACHMENT #4 MAPS or Pages 13-20

CITIZEN COMMENTS- NARRITIVE
PROPOSED UPDATE TO STORMWATER MASTER PLAN – CITY OF TUALATIN

My husband and I are submitting these Citizen Comments regarding the newly posted first draft (December 1, 2020) of the proposed City of Tualatin Stormwater Management Master Plan Update. Utilizing the State's Land Use Planning Goals as a basis for our concerns. We mention there are multiple other related local, State and Federal mandates which exist and provide additional measures to address stormwater management, property rights and protections, safety, conservation and protection of Natural Resources, and coordination and integration of Public Services with other governmental units or agencies.

STATE OF OREGON STATEWIDE LAND USE GOALS- Used as basis and support of concerns being presented
OAR 660-015-0000 Oregon Statewide Land Use Planning Goals

The state of Oregon has established goals and provided mandates for Land Use Plans – including specific requirements which should be included within the Land Use Plans of local city governments- including City Master Plans.

These Land Use Planning Goals not only provide a framework for creating a Land Use Plan, but they also provide a method for evaluation of various Land Use elements to be included within a potential Plan, as well as mandates for compliance.

Included within our comments are references to these Land Use Planning requirements to provide a common understanding of the basis for our comments and as support for request for resolution to concerns provided within this correspondence.

Land Use Planning Goal #2- LAND USE PLANNING OAR 660-015-0000 (2) provides the framework for the development and requirements for the development of a Land Use Plan- such as the City's proposed Stormwater Management Master Plan Update. Included with Goal #2 are the following goals and mandates apropos to these comments: (emphasis added)

- To establish a land use planning process and policy framework ***as a basis for all decision and actions related to use of land*** and ***to assure an adequate factual base*** for such decisions and actions.
- City, county, state and federal agency and special district plans, and actions related to land use **shall be consistent with the comprehensive plans of cities and counties and regional plans** adopted under ORS Chapter 268.
- All land use plans shall include:
    - ***identification of issues and problems, inventories and other factual information*** for each applicable statewide planning goal,
    - **evaluation of alternative courses of action and ultimate policy choices**, taking into consideration social, economic, energy ***and environmental needs*****.**

- The required information ***shall be contained in the plan document or in supporting documents***

- **The plans shall be the basis for specific implementation measures.**
  - **These measures shall be consistent with and adequate to carry out the plans.**
  - All land-use plans, and implementation ordinances shall... be reviewed and as needed, revised on a periodic cycle ***to take into account changing public policies and circumstances***

It is important that accurate fact-based information relating to potential Land Use actions are obtained and provided as part of any Land Use action. Both Citizens and those who may ultimately be making Land Use decisions require accurate representative unbiased information so that they may understand and comprehend issues pertaining to proposed Land Use issues. This process assists and promotes the transparency of the governmental process, and informed decision making.

Unfortunately, after review of the City of Tualatin's proposed Update to the Stormwater Management Master Plan, my husband and I have found multiple issues which reduce compliance with the Oregon Land Use Planning Goals, as well as other local, State and Federal mandates-particularly with respect to the Land Use Planning for the Basalt Creek Area under the current or future jurisdiction of the City of Tualatin, and/or under other overlapping governmental units or agencies.

HISORICAL LAND USE PLANNING ACTIONS-BASALT CREEK AREA & STORMWATER MANAGEMENT

My husband and I strongly support the City's efforts to review and revise the City's dated Stormwater Management Master Plan which according to the City's website was adopted in 1972

https://www.tualatinoregon.gov/sites/default/files/fileattachments/engineering/page/13099/tualatin_drainage_plan_sept_1972.pdf

A request had to be submitted to the City for access to the Appendices for the proposed Plan.

In the decades since the City's Stormwater Management Plan was adopted in 1972, the type and level of assessment, knowledge and implementation of stormwater management has greatly expanded, and the potential impacts more fully understood. The relevance of impact of Land Use Actions upon the environment has also become more greatly understood, expanding the need for a more comprehensive assessment and analysis of potential outcomes as part of the Land Use Planning process.

In 2004 Metro 04-1040B authorized the addition of the "Tualatin Area" (part of which is now known as the Basalt Creek Area) into the UGB. Metro imposed multiple conditions and requirements for the conservation and protection of multiple natural resources as part of Metro 04-1040B as part of the responsibilities of the local governments.

In 2018 the Basalt Creek Concept Plan jointly authored and adopted by the Cities of Wilsonville and Tualatin -taking the initial steps in the Land Use Planning of over 800 acres within the Basalt Creek Area and included various assessments of Natural Resources within the Basalt Creek Area.

Included within the Basalt Creek Concept Plan are various statements relating to Land Use Planning within the Basalt Creek Area including:

"New stormwater infrastructure will be primarily integrated with the local road network"

..."It is assumed that the existing culverts may not have capacity for future urban conditions and will need to be upsized to provide adequate capacity for runoff from new impervious areas, unless onsite detention or

infiltration is required when the location of public drainage or the topography of the site make connection to the system not economically feasible." *(emphasis added)*

"The Cities and CWS will adopt an Intergovernmental Agreement that will address areas where cooperative stormwater management is needed."

It is unclear if and when such Stormwater Management Planning for the Basalt Creek Area between these three entities was conducted.

Both Cities also stated within the Concept Plan- they would have "Joint Management" of the "Natural Area" within the Basalt Creek Canyon.

It is unknown what further action has been taken to implement the "Joint Management" of the lands in the center portion of the Basalt Creek Area- where a high percentage of the Natural Resources are located within the Basalt Creek Canyon.

It is not known what Land Use elements of "management" were intended to be the focus of this joint statement, but the potential involvement of the City of Wilsonville within the Land Use Planning of the Basalt Creek Area may result in additional complexities in the determination and implementation of Land Use planning within the Basalt Creek Area.

As the Basalt Creek Canyon receives a majority of the stormwater drainage from the area, the potential involvement and coordination of the City of Wilsonville should be included within any Stormwater Management plan within the Basalt Creek area. The identification of this information was not included within the City's proposed Update to the Stormwater Master Plan.

Included within the Basalt Creek Concept Plan are numerous maps identifying the location of multiple Natural Resources existing within the Basalt Creek Area mainly generated from Metro 2001 data. This type of information regarding Natural Resources within the Basalt Creek Area was not included within the maps the City elected to adopt within the City of Tualatin Basalt Creek Comprehensive Plan and the subsequent adoption and integration into the City's Governing Documents.

A few examples of the maps from the Basalt Creek Concept Plan are included as attachments to this correspondence to help substantiate:

- the existence of these Resources,
- the need for the City of Tualatin to conduct a more current assessment and analysis of multiple Natural Resources known to exist within the Basalt Creek Area for fact-based decision making,
- the need for the City to memorialize the information into the City's Governing Documents to:
    - establish fact-based documents which have evaluated significant factors which exist within lands the City sought to gain future jurisdiction -which are equal to or exceeding the level provided to the majority of the lands within the City.
    - Provide consistency of fact-based documents within the City which various departments can utilize as part of a decision-making process
    - Provide an accurate fact-based reference for use by the Public to gain understanding of the basis for future decisions

These actions will provide greater consistency within all proposed Land Use Plans -including the Stormwater Management Master Plan and may provide greater compliance and positive outcomes in subsequent implementation actions.
Attachment #4 Maps

In 2019, the City of Tualatin Basalt Creek Comprehensive Plan, did not provide stormwater management plans specific for the Basalt Creek Area or a stormwater system map specific to the Basalt Creek Area.
The City has left developers to be responsible for on-site Stormwater Management.

But the City did not identify what actions will be taken if financial costs become too high, if stormwater management requirements exceed onsite management and/or treatment capabilities or should other factors which might preclude full onsite stormwater management and/or treatment develop.

The City did not provide specific guidance as to:

- feasibility of integration into the County's existing stormwater management system (which is already known to be at capacity)
- mechanisms for cooperative planning and integration into the County's existing stormwater management system
- the process and funding to collect, convey, treat and dispose of excess stormwater runoff off site, or
- the role for Citizen Involvement by downstream property owners or other stakeholders.

The proposed Update to the City of Tualatin's Stormwater Management Master Plan does not acknowledge these issues nor provide information as to this issue.

There are questions as to the consistency of the City's Land Use Plans for Stormwater Management planning and implementation for development.

Contrary to the efforts taken to meet compliance requirements within the Basalt Creek Concept Plan, the City of Tualatin elected as part of the Basalt Creek Comprehensive Planning process, to omit maps within the Basalt Creek Area which denoted the existence of multiple Natural Resources within the Basalt Creek Area- which had been included in the Concept Plan.

The lack of information as to the assessment and location of multiple Natural Resources which have requirements for their conservation and protection, causes significant issues as to the ability to comply and implement various Metro, State and Federal requirements to conserve and protect Natural Resources based upon facts.

Consequently, lacking the inclusion of the assessment of the Natural Resources within the City's Governing Documents, inhibits the ability to effectively identify and mitigate negative impacts from Stormwater Drainage as part of the Master Plan for Stormwater Management and in the planning and implementation of any Land Use Action.

Within the City's Basalt Creek Comprehensive Plan -included as a supporting document- is a letter dated 12-5-2006, titled **"City of Tualatin Title 13 and Tualatin Basin Plan Compliance Review."** (Exhibit 6 to Ordinance No. 1418-19

There are several concerns presented by the inclusion of this letter with issues relating to the Basalt Creek Area:

- Although the City has posted this letter on the City's Planning Department's Basalt Creek website, it is unclear as to the relevance of this letter to issues related to the Basalt Creek Area
- The letter is date specific and does not provide information as to changes which may have occurred within the 14 year since it was authored.
- The letter is dated 12-5-2006, prior to the City of Tualatin's right to conduct Land Use Planning for lands within the Basalt Creek area-outside its jurisdiction at the time. It is not known if the scope of subject matter within the review included lands within the Basalt Creek Area.
- It appears the intent of the letter was to evaluate a program, and not an evaluation of Title 13 resources- the letter clearly makes that statement.
- The letter included several statements as to additional actions required for compliance- including issues relating to the need for documentation of identification of various Natural Resources.
- The City did not attach documentation of successful implementation of actions required within the letter, nor application of results of the Tualatin Basin Program and application to the Basalt Creek Area.
- Of most importance the letter states: *"The compliance review by Metro is a review only of whether the amendments Tualatin is proposing are consistent with the UGMFP and <u>is not a review of whether Tualatin has complied, or will comply with the other requirements of Option 5 and the Tualatin Basin Program</u>.* (emphasis added)

  In relevance to the proposed Stormwater Management Master Plan Update, the 2006 Metro letter included the following information:

  > *<u>Stream crossings and detention ponds</u>:* We also note that for a number of HFDPs - such as minimizing stream crossings, encouraging perpendicular crossings, using habitat sensitive bridge and culvert designs, use of detention ponds, and allowance of narrow road widths through stream corridors - the City does not propose any code changes. Instead, the City states that its code is silent on such practices, but does not prohibit them, and mostly relies on its adoption of Metro's Title 3 and CWS requirements to meet Title 13's "encourage and facilitate" requirement.
  >
  > <u>Recommendation</u>: We recommend that the City amend its code to affirmatively support these HFDPs. Doing so would leave no doubt that the City is encouraging and facilitating these HFDPs.
  >
  > It is not known if the City implemented this recommendation- or if the recommendation is still relevant.

  If the use of this letter is intended to indicate compliance to mandates for the conservation and protection of Natural Resources within the Basalt Creek Area, it would seem prudent for the City to establish documentation of an assessment of the Natural Resources within the Basalt Creek Area, and documentation of actions taken by the City to comply with such mandates- based upon current facts and standards to meet compliance needs.

In 2020, the City of Tualatin started actions to annex large acres of land within the NE portion of the Basalt Creek Area. A large portion of these lands currently act as the stormwater catchment, retention, and reabsorption basin for the greater area. The City is currently taking Land Use Planning actions which will allow the development of over 60 acers of this current stormwater catchment area.

Along with the removal of several acres which contain many characteristic factors of a natural stormwater catchment area (which have decreased the flow and velocity of stormwater and increase its reabsorption), future development may remove these factors while significantly increasing impervious surfaces with the creation of buildings, streets, and parking lots.

CURRENT CONCERNS REGARDING THE PROPOSED STORMWATER MASTER PLAN UPDATE

TECHNICAL ISSUES

A summary of the Technical Issues presented within the Stormwater Master Plan Update are summarized at the beginning of this correspondence, with the full review included as a Google Link attachment #1, #2 #3.

It is readily apparent when reading the proposed Master Plan Update, that much of the information contained with the draft is dated, and not reflective of current issues, or needs.

Page 5-2 includes the following information:
"Basalt Creek runs north-south in the southern portion of the City. Much of the contributing land use is low-density and rural residential, ***but with pending adoption of the Basalt Creek Concept*** *Plan concept plan [sic], future development is anticipated to impact the contributing land use and stream condition. Ownership is currently private and public (City)." (emphasis added)*

The Basalt Creek Concept Plan was adopted by the Cities of Wilsonville and Tualatin in 2018, indicating the proposed plan may not have been revised as to changes within the Basalt Creek Area for over two years. Since that time, the City of Tualatin generated and adopted the Basalt Creek Comprehensive Plan.

Although the proposed Stormwater Management Plan readily identified and anticipated the negative impact future development within the Basalt Creek Area would have upon the stream condition- the proposed Plan did not identify actions to be taken to provide further assessment and/or alternative solutions to attempt to address and mitigate stormwater impact upon the "stream condition".

IMPACT NATURAL RESOURCES

A review of the City's newly proposed draft to Update the City of Tualatin Stormwater Management Master Plan, does not currently identify the evaluation of Natural Resources within the Basalt Creek Area, nor the methods to be utilized to ensure compliance with the various mandates for the conservation and protection of numerous Resources. The State Land Use Goal requires documentation of compliance with State Goal #5 NATURAL RESOURCES AND OPEN SPACES, and State Goal #6 AIR, WATER AND LAND RESOURCES QUALITY which are the basis upon many of our concerns regarding the proposed Update to the City's Stormwater Master Plan.

NEED FOR COORDINATION OF LAND USE PLANNING WITH OVERLAPPING GOVEMENTS- STATE GOAL #2

While both Cities had knowledge of, and participated within the decision making Land Use Planning process in planning the location of Washington County's proposed Basalt Creek Parkway Extension regional transportation 5+ lane expressway through the middle of the Basalt Creek Area--- neither the Basalt Creek Concept Plan nor the City of Tualatin

Basalt Creek Comprehensive Land Use Plans acknowledged, addressed or provided guidance as to coordination of stormwater management planning within the Basalt Creek Area for Washington County's proposed major transportation project within overlapping jurisdictions.

It is unclear as to the amount of land Washington County will require for their proposed project which will needed not only for road construction, but also a proportionally large amount of land for stormwater management and treatment within wetlands and other lands within the future jurisdiction of the City of Tualatin. Nor did either plan address or provide guidance (and intended compliance) as to how all local governments would ensure conservation and protection of various Natural Resources within the Basalt Creek Area from direct or indirect effects of stormwater or stormwater management which might be caused by the proposed project and potential impact upon Natural Resources within the future jurisdiction of the City of Tualatin.

Compounding the lack a clear plan for a coordinated Stormwater Management plan to address the permanent installation of this major transportation project through multiple Natural Resources, the Basalt Creek Concept Plan states, "joint management" management of the "Natural Area" within the Basalt Creek Area by the Cities of Wilsonville and Tualatin and introduces a possible intergovernmental agreement between the two Cities for stormwater management within the Basalt Creek Area.

Due to the proximity of the eastern terminus of the proposed Washington County Basalt Creek Parkway Extension on SW Boones Ferry Road, and the and anticipated City of Tualatin major residential development of 400+ units and Commercial Neighborhood development within approximately 1/4 mile, of each other on SW Boones Ferry Road, there will be significantly increased need and demand for Stormwater Management and treatment with a limited geographic area and in lands with over lapping governmental jurisdictions.

As my husband and I are potentially affected property owners, we have on multiple occasions reached out to the staff of both the City of Tualatin and of Washington County to gain a better understanding how the Land Use planning actions by both governments are coordinating Land Use planning within the area. We have expressed our desire to be able to have potentially affected property owners participate in the coordinated planning of major Land Use Projects on lands near overlapping jurisdictions due to various direct and indirect impacts upon our property. We have not gained much success in these actions.

Unfortunately, there appears to be a continued lack of coordination and communication between these two entities as to the conception, planning and design of major Land Use Projects within the Basalt Creek Area.

Recognizing the lack of effective coordination in Land Use Planning by these two local governments, and to promote better compliance with mandates for the coordination of planning for Public Services by local governments, a well authored Stormwater Management plan would include clear requisites to:

- identify major Land Use Projects under consideration by another government (as a potential constraint or added factor in Land Use Planning)
- provide guidance as to how to coordinate the provision of Public Services within overlapping jurisdictions.

The proposed Stormwater Management Plan does not address this issue or provide clear guidance for implementation.

CURRENT STORMWATER MANAGEMENT SYSTEM WITHIN BASALT CREEK AREA
- HAS PREVIOUSLY FAILED AND IS A LIMITATION AND CONSTRAINT FOR FUTURE DEVELOPMENT
- IS UNDER THE JURISDICTION OF --OR IMPACTED BY–
LAND USE PLANNING ACTIONS OF OTHER LOCAL GOVERMENT

The current Stormwater Management System along SW Boones Ferry Road within the Basalt Creek Area was designed and constructed as part of Washington County's SW Boones Ferry Road Improvement Project (2012-2015). During the design phase of this Land Use transportation project, my husband and I contacted the County on multiple occasions regarding our concerns of potential negative downstream stormwater impacts we identified within the proposed design. We were assured the outflow from the County's design would be equal or 10 % less than stormwater outflow which we previously experienced from a more primitive/less sophisticated stormwater system.

The 2016 Stormwater Analysis within the Basalt Creek Area by Mr. La Liberte' which was the basis of the report, *"Effects of SW Boones Ferry Road Construction (2013-2015) Stormflow Analysis for the Lucini Property Washington County, Oregon"*, was generated due to my husband's and my desire to understand the cause of flooding into our property from stormwater emitting from a Washington County Stormwater Outflow an apparent failure of the stormwater management system in 2015. There have been no significant changes made to the County's Stormwater system since 2015 upstream from our property.

Currently a large percentage of the stormwater drainage from the NE portion of the Basalt Creek Area flows south- eventually through the City of Wilsonville and into the Willamette River. Much of the stormwater within the NE portion of the Basalt Creek Area is captured within a stormwater catchment basin on undeveloped lands east of SW Boones Ferry Road, and collected within Washington County's stormwater collection, conveyance and treatment system. A majority of the stormwater catchment basin on the east side of SW Boones Ferry Road and north of Greenhill Lane is on lands recently annexed into the City of Tualatin.

The stormwater drainage from this area flows away from the majority of lands within the City of Tualatin and outside of the City of Tualatin's existing stormwater collection, conveyance and/or treatment facilities.

Mr. La Liberte's study identified multiple factors which lead to the flooding of our property from the stormwater system which currently exists within Basalt Creek Area in the area around SW Boones Ferry Road.

From this investigation we gained knowledge that the **County's design and planning for the stormwater management system installed along SW Boones Ferry Road as part of the SW Boones Ferry Road Improvement Project, was:**

- **based upon drainage needs of undeveloped land, and**
- **not designed to meet anticipated drainage needs of developed lands with higher nonporous surfaces (buildings, streets, and sidewalks etc.) which cause higher stormwater runoff and less reabsorption into the land which has previously acted as a major stormwater catchment area.**

Both the City of Tualatin, and Washington County are undertaking Land Use planning actions within the Basalt Creek Area affecting properties under overlapping jurisdictions. My husband and have on multiple occasions attempted to gain insight as to the coordination of Stormwater Management Planning within the Basalt Creek Area from these two local governments.

As downstream property owners within Washington County, we have specifically expressed concerns and requested Land Use Planning information from the City of Tualatin as to the City's Stormwater Management Plan within the Basalt Creek Area and of potential impacts upon the current existing system under the jurisdiction of Washington County - during the Basalt Creek Concept Planning, during the City of Tualatin Basalt Creek Comprehensive Planning and as part of the City's annexation process for ANN 19-2002- without fact based information which would provide us understanding of the City's proposed Land Use actions and potential impacts caused by increased needs or changes to this Public Service. The Basalt Creek Concept Plan adopted by the City in 2018 acknowledged limitations within the existing Stormwater Management system within the Basalt Creek Area and identified the need for system upgrades with development of the Basalt Creek Area.

We have specifically asked the City of Tualatin and Washington County on multiple occasions how both of these two local governments have coordinated the Land Use Planning Goals for Washington County's proposed Basalt Creek Parkway Extension Project. Our questions have included how Stormwater Management will be integrated into the County's existing Stormwater System, how or where additional conveyance and/or treatment facilities will be located within lands with overlapping jurisdictions and of potential impacts to the City of Tualatin's Land Use Planning for the urbanization of the Basalt Creek Area and associated increased stormwater management needs on private or public lands. Again, my husband and I have received little fact-based information as to how these two local governments with over lapping jurisdictions have conducted Land Use Planning for a key Public Service of Stormwater Management within an area containing multiple known constraints and limitations.

My husband and I have reasonable concerns as to potential negative impacts from stormwater due to poorly planned and executed Land Use actions. The need for a well-developed integrated Stormwater Management plan for the Basalt Creek Area is necessary for the safety and protection of Citizens, property and surrounding Natural Resources.

Thank you for the opportunity for participating in this first Citizen Involvement Public event for the City's Proposed Update for the Stormwater Master Plan.

My husband and I look forward to hearing what steps the City will be taking the City's adoption process for this proposed Land Use Plan Action

As Citizens and potentially affected property owners, we request Actual Notice of any future Public Meetings-where this proposed Land Use Action may be an agenda topic--- including but not limited to the City of Tualatin Planning Commission, and/or the Tualatin City Council.

Respectfully submitted,

Grace Lucini
John Lucini
23677 SW Boones Ferry Road
Tualatin, OR 97062

ATTACHMENTS #1, #2, & # 3 Documents La Liberte' Environmental Associates (Google Link)
#4 MAPS (Google Link) & (Hard Copy Pages 13-20)

ATTACHMENT #4

MAPS WITHIN PROPOSED UPDATE TO THE CITY'S MASTER PLAN

PROPOSED MAPS:
-CONTAIN DATED INFORMATION
-OMISSION OF RELAVENT AND NESSARY INFORMATION REQUIRED FOR LAND USE PLANNING

An example of questionable information provided within many maps within the proposed Stormwater Management Plan for the City, is **Figure 2-2 Project Area Overview**.

T**he Legend within Figure 2-2 provides keys as to the location of**
- **Open Space-Parks/Greenways/Natural Areas/Private***
- **Open Space- WPA/Setbacks/NRPO/Wetlands**

However, there is no indication of the wetlands, and multiple Natural Resources known to exist within the Basalt Creek Area and within the Basalt Creek Canyon.

Many of these types of Natural Resources may be negatively affected by stormwater drainage, and an accurate assessment as to the quantity, quality and location of Natural Resources which are to be conserved and protected should be assessed evaluated and memorialized within a Stormwater Management Plan and integrated into the City's Governing Documents for to provide and assure consistency within the City's various Land Use Plans.

Another factor not denoted within the maps within proposed Stormwater Management Plan, is the identification of the "Natural Area" within the Basalt Creek Canyon.

This area which contains wetlands and various Natural Resources requiring conservation and protection was identified within the Basalt Creek Concept Plan in which both Cities agreed to have "joint management" of the "Natural Area". It would seem reasonable this information which might impact Land Use Planning within the Basalt Creek Area and is downstream from the Basalt Creek lands already annexed into the City, would be identified on the Figure 2-2 map, and include additional information within the narrative of the proposed Stormwater Management Plan as a potential constraint or limitation in the planning of Stormwater Management in the area or upstream from the "Natural Area".

This map also includes the notation of "Brown and Caldwell City of Tualatin Stormwater Master Plan Date: April 2019 Project 149233 in the lower left corner of the map. An assumption would be that the information provided within this map would be current and accurate as of April 2019- the date indicated on the lower left corner of the map. It is unknown how current the information contained within this map may be but lacking the inclusion of information Basalt Creek Area lands already within the City's boundaries, makes one question when the data for this map was last collected.

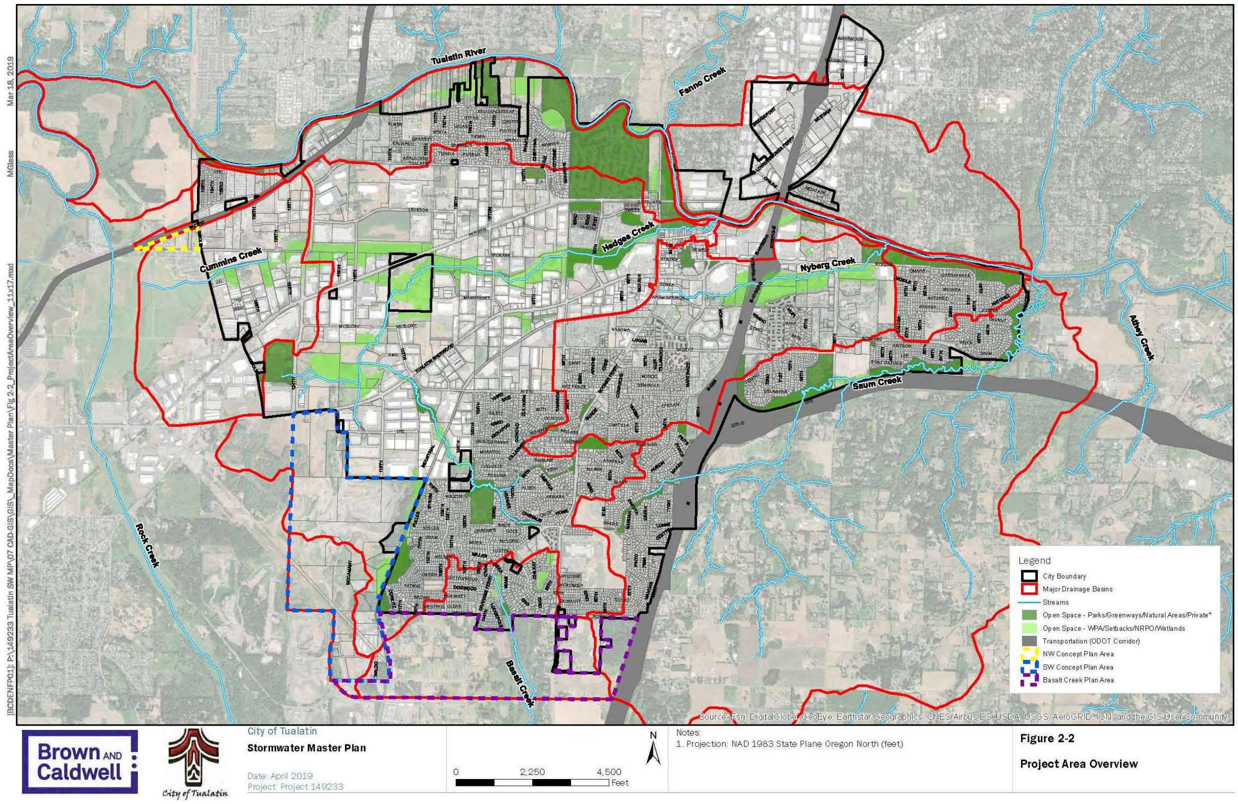


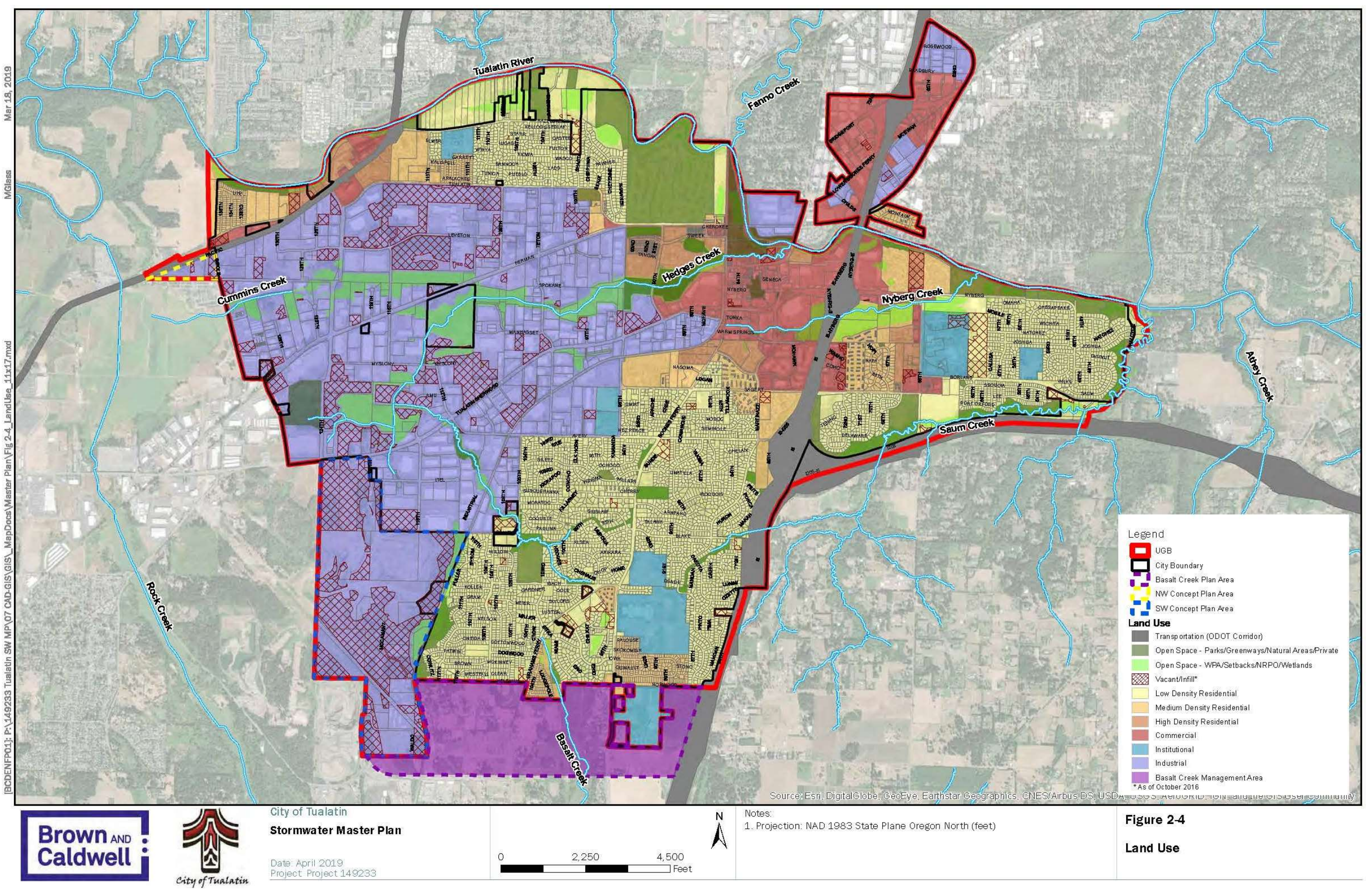
Figure 2-2

Project Area Overview

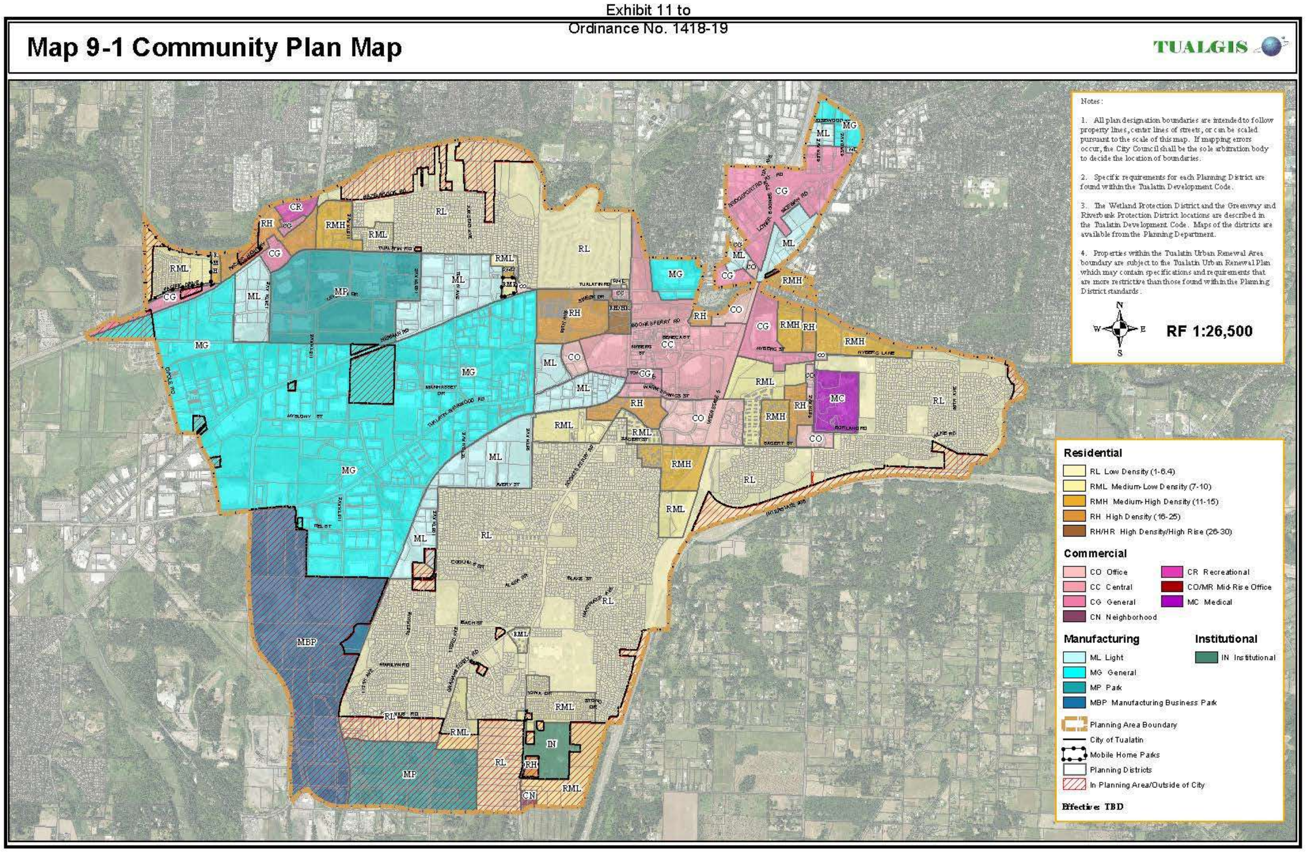
Figure 2-4 "Land Use" Map Not Consistent with City's Current Land Use Zoning
also provides the notation of "Brown and Caldwell City of Tualatin Stormwater Master Plan Date: April 2019 Project 149233 in the lower left corner of the map.

Yet, an asterisk notation within the Legend box states, "* As of October 2016".
Major changes have occurred as to Land Use within the City of Tualatin in the four years since this map was apparently generated.

The information provided as to the Land Use zoning or designations do not accurately reflect the Land Use Planning Actions of the Basalt Creek Concept Plan adopted in 2018, nor the City of Tualatin Basalt Creek Comprehensive Plan. Land Use Zoning within the Basalt Creek Area does not provide accurate information of current Land Use Zoning and Planning within the Basalt Creek Area and may hinder the planning for Stormwater Management in the assessment of current and future needs based upon type of land use. Approximately 60 acres within the Basalt Creek Area have already been annexed into the City of Tualatin, and into the responsibilities and regulations of the City for Land Use planning- including Stormwater Management.



The proposed Stormwater Master Plan Update is not consistent with the Land Use Plan adopted by the City in 2019 in Ordinance 1418-19, and consequently would not be compliant with Statewide Planning Goal #2

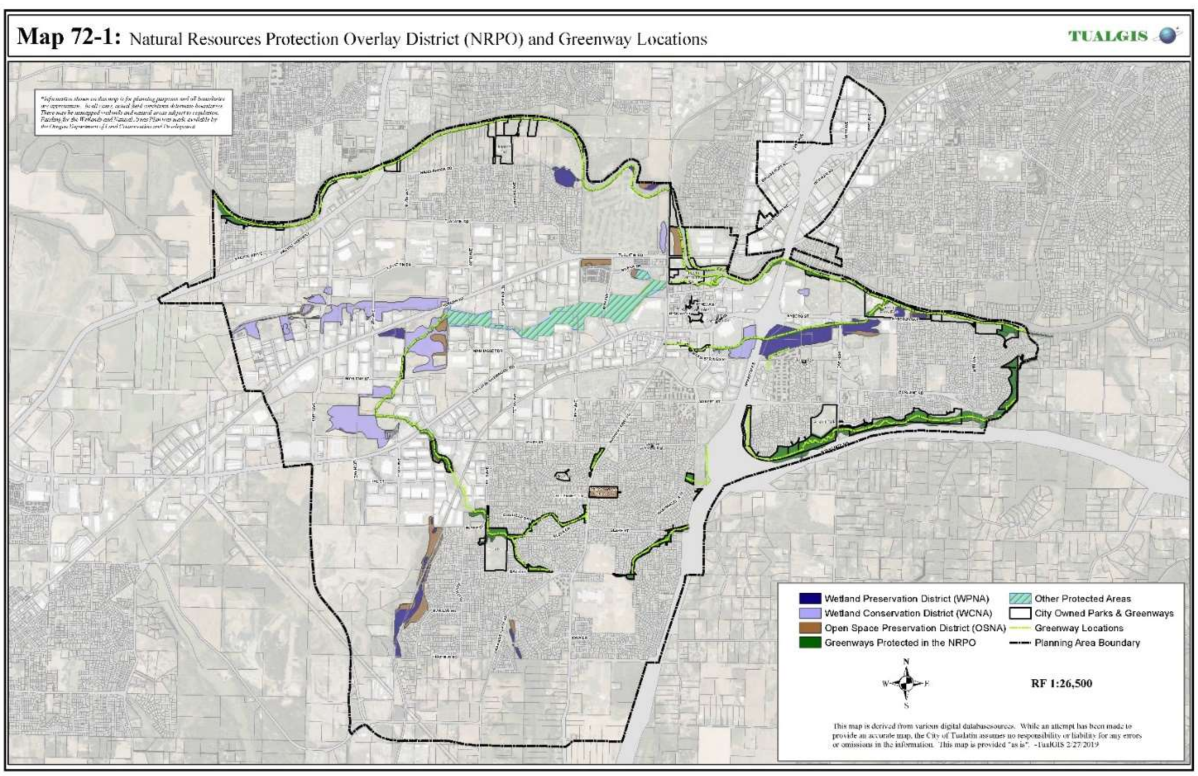


72-1 Natural Resources Protection Overlay district (NRPO) and Greenway Locations
72-3 Significant Natural Resources
There is an absence of necessary information provided for the Basalt Creek Area for Natural Resources

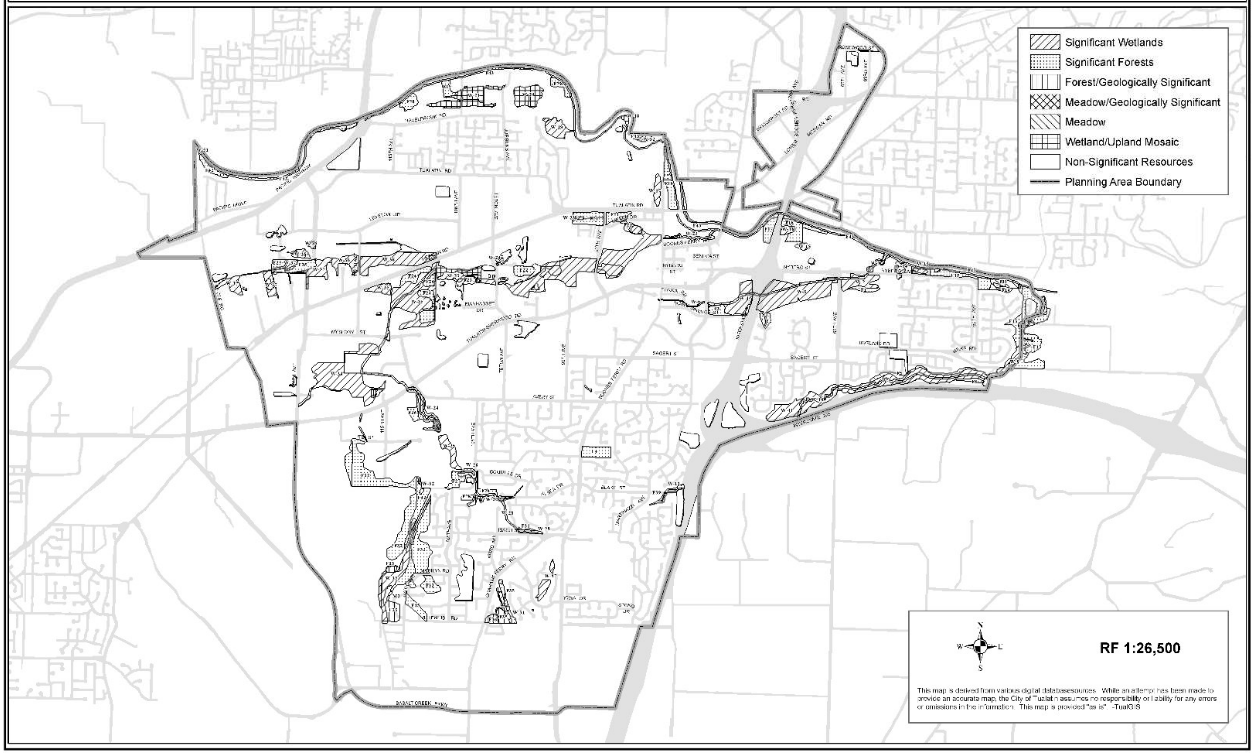
Lacking necessary evaluations as to the level, location and quality of Natural Resources within the Basalt Creek Area within the proposed Stormwater Management Master Plan Update, it would be difficult for the City of Tualatin to utilize the maps adopted into the City's Governing Documents (as part of the adoption of the Basalt Creek Comprehensive (Ord. 1427-19 , § 47, 11-25-19)), as supportive or back up documents to the proposed Update, as these maps obtained from the City's website do not identify or provide substantive information as to the multiple Natural Resources which are known to exist within the Basalt Creek Area.

City of Tualatin Maps downloaded from the City's municipal Code website
https://library.municode.com/or/tualatin/codes/development_code?nodeId=THDECOTUOR_APXAMA

also lack essential information necessary for the development of a Land Use Plan, or effective implementation of a Land Use Action within the Basalt Creek Area and are not suitable support documents for the proposed Update to the City's proposed Stormwater Management Master Plan Update.



Map 72-3: Significant Natural Resources



There are signficant inconsistancies in the level of acknolwedgement and identification of various Natural Resourcse which are required to be evaluated for potential impact within all Land Use Plans, and Planning Actions. The omission of pertenant information regarding the existance of multipe Natural Resources within the northern portion of the Basalt Creek Area as presented within the City's Governing Documents, and within the City's proposed Stormwater Master Plan update are notable.

However, the City included the Basalt Creek Concept Plan document adopted by the City in 2018, and utilized as a supporting document to the Basalt Creek Comprehensive Plan in 2019 did provide needed information as to Land Use evaluative factors such as the Natural Resources and contraints which exist within the Basalt Creek Area.

Examples of pertenent documentation from the Basalt Creek Concept Plan as to the quanity and quality of these Natural Resources is provided including a summary of a rational for inclusion of this information into the Basalt Creek Land Use Concept Plan.

Metro Title 13: Nature in Neighborhoods

Title 13 requires local jurisdictions to protect and encourage restoration of a continuous ecologically viable streamside corridor system integrated with upland wildlife habitat and the urban landscape. Metro's regional habitat inventory in 2001 identified the location and health of fish and wildlife habitat based on waterside, riparian and upland habitat criteria. These areas were named Habitat Conservation Areas.

Table 7 Title 13 HCA Categories with Acreage

HCA Categories	Acres	Description
Riparian Wildlife Habitat Class I	130	Area supports 3 or more riparian functions
Riparian Wildlife Habitat Class II	31	Area supports 1 or 2 primary riparian functions
Riparian Wildlife Habitat Class III	7	Area supports only secondary riparian functions outside of wildlife areas
Upland Wildlife Habitat Class A	103	Areas with secondary riparian value that have high value for wildlife habitat
Upland Wildlife Habitat Class B	72	Area with secondary riparian value that have medium value for wildlife habitat
Upland Wildlife Habitat Class C	37	Areas with secondary riparian value that have low value for wildlife habitat
Designated Aquatic Impact	52	Area within 150 ft. of streams, river, lakes, or wetlands

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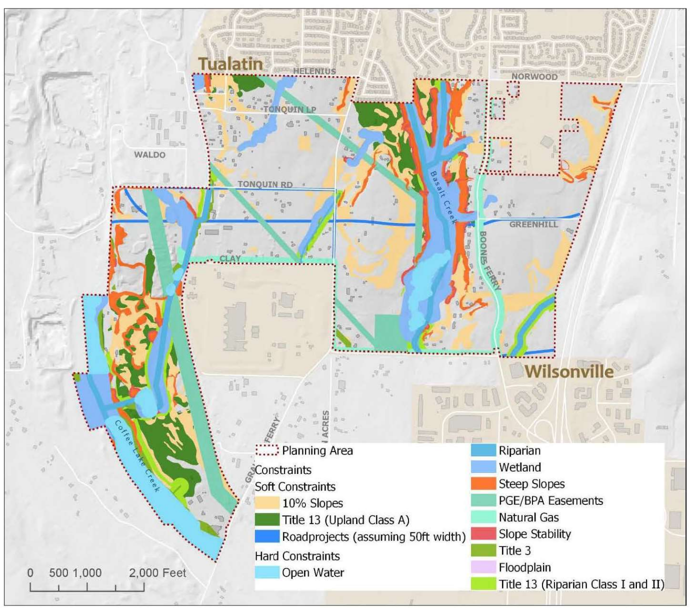
Exhibit 2 to
Ordinance No. 1418-19

Environmental constraints are summarized below and unless otherwise noted were fully excluded from the developable land input in the scenario testing for the Basalt Creek Concept Plan:

- Open Water
- Streams
- Wetlands
- Floodplains (50% reduction of developable area)
- Title 3 Water Quality and Flood Management protections
- Title 13 Nature in Neighborhoods (20% reduction of developable area in areas designated Riparian Habitat Classes I and II)
- Steep Slopes (25% slopes and greater)

Figure 13 Natural Resources Map



42

It is unclear as to the rational for the omission of pertenent information required to be an evaluated compent in the development of all Land Use Plans and implmentation of Planning Actions have not been included within the proposed Stormwater Master Plan Update, nor in the City's Governing Documents as provided via the City's

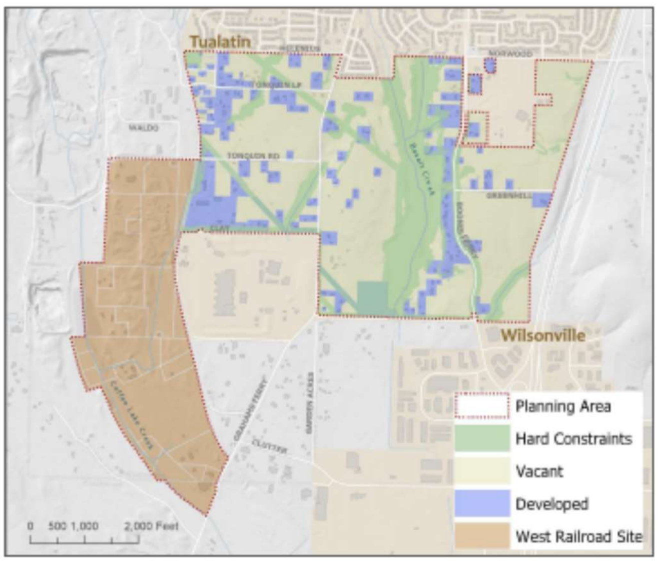
Exhibit 2 to
Ordinance No. 1418-19

The goal is to classify every parcel within the Planning Area into one of the categories described below:

Table 2 Land Supply within the Basalt Creek Planning Area by Type and with Acreage.

Land Supply by Type and Acreage		
Land Type	**Acres**	**Description**
Vacant Land	331	Unconstrained land that is ready to build with no major structures located on the site
Developed Land	125	Land already built upon which includes acreage covered by roadways
Constrained Land	153	Land that cannot be built upon due to environmental or other hard constraints
West Railroad Area	238	Excluded from development plan due to large amount of constraints and limited access
Total Land Supply	**847**	

Figure 6 Land Supply by Type.



21

LEA Comments
On the Draft Tualatin Stormwater Master Plan
(Dated April 2019)

Prepared for
John and Grace Lucini
23677 SW Boones Ferry Road
Tualatin, Oregon
97140

Prepared by
Dave LaLiberte
Principal Engineer
Liberte Environmental Associates, Inc.
Wilsonville, Oregon

December 14, 2020

Draft Comments on the Tualatin Stormwater Master Plan (Draft, April 2019)

Due December 15, 2020, by Dave LaLiberte, P.E., Liberte Environmental Associates (LEA)

Summary Comments

These comments are based on the Draft Tualatin Stormwater Master Plan (SWMP) dated April 2019. Comments highlight issues in the Plan concerning Southwest Boones Ferry Road (BFR) south of Norwood Road, referred to as “BFR south”.

Significant problems in the Plan for the BFR south area are: lack of identified stormwater facilities[1] omission of hydrologic and hydraulic modeling analysis[2], potential for mis-application of design alternatives[3], absence of stormwater problem acknowledgement and evaluation[4], no assessment of stormflows on steep slopes[5], effect of stormflows on the Basalt Creek Concept Plan are neglected[6], no existing and future development stormwater flows are compared[7], protection of natural resources is unclear[8], no designation of Capital Improvement Projects (CIPs[9]) in the BFR south area, and other Plan related problems.

Supplement documents collected by Liberte Environmental Associates (LEA) for these comments are identified as:

Supplement A - LEA Request for Tualatin SWMP Appendices

Supplement B - *Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property* (LEA, November 2016).
This report is included in two parts: Supplement B Part 1 (Report) and Part 2 (Appendices) under separate cover because of their size.

Supplement C –David M. LaLiberte, P.E., Cumuli Vitae (CV)

David M. LaLiberte, P.E., Civil and Environmental Engineer licensed in the State of Oregon, has compiled these comments under contract with John and Grace Lucini (see Comment LEA2 below). Dave has over 30 years of experience in stormwater, water quality and design solution analysis. His education and experience are attached as Supplement C – Cumuli Vitae (CV).

---

[1] See Specific Comment LEA6.

[2] See Specific Comment LEA5.

[3] See Specific Comment LEA9.

[4] See Specific Comments LEA9, 11 and 14 as they pertain to the SWMP Table 3-1 and Figure 7-1.

[5] See Specific Comments LEA5, 7 and 8.

[6] See Specific Comments LEA6, 7, 8, 12 and 15.

[7] See Specific Comment LEA5.

[8] See Specific Comment LEA6.

[9] See Specific Comment LEA4, 9, 10 and 11.

Specific Comments

Comment LEA1. Many of the questions raised in these Tualatin SWMP comments focus on the area along BFR south. The BFR south area is shown within the city limits in all of the corresponding master plan figures. That is: Figures ES-1, 2-2 through 2-6 and 7-1.

Comment LEA2. Many of these comments refer to *Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property* (LEA, November 2016), contracted by John and Grace Lucini, 23677 SW Boones Ferry Road, Washington County, Oregon, Tualatin, Oregon, 97140. This report is referred to as the "Stormflow Analysis" and is attached to these comments as Supplement B Part 1 (Report) and Part 2 (Appendices).

Comment LEA3. The Tualatin SWMP Appendices were obtained (Dec 10, 2020) from the City of Tualatin as part of this comment period ending December 15, 2020. A description of the SWMP Appendix request is contained in LEA Supplement A.

Comment LEA4. Some of the comments reference procedures in other areas of Tualatin. For example, Project Opportunity Area 6 – Alsea, aka Capital Improvement Project #17 (CIP17), calls for infiltration/retention that could be erroneously applied to the BFR south area. These procedures will potentially be applied to the hydrologic and hydraulic modeling in BFR south, and possibly any resulting CIP and stormwater design considerations.

Comment LEA5. The Tualatin SWMP does not include any hydrologic or hydraulic (H/H) modeling for stormwater flows in BFR south. The SWMP must include H/H modeling of the BFR south and affected areas such as the Basalt Creek corridor. Stormwater piping, channels, inlets, outfalls and other stormwater related facilities exist in BFR south (see LEA Supplement B Part 2: Appendices B through E) but are undocumented and un-analyzed in the SWMP. A perusal of the Tualatin SWMP Appendices A through C demonstrates that engineering data and analyses have all been omitted for the BFR south area. The SWMP must include stormwater facilities in Figure 2-6 – Stormwater System Overview for the BFR south and affected areas such as the Basalt Creek corridor. Comparison existing and developed future stormwater flow conditions are not performed. Evaluation of stormflows on hazardous steep slopes is omitted. Assessment of downstream conveyances below Tualatin outfalls is not conducted for the BFR south impacted areas.

Comment LEA6. The Tualatin SWMP does not include any wetlands in BFR south although they do exist. The SWMP Figure 2-5 - Stream Ownership omits the majority of stormwater impacted wetlands in Tualatin. Metro's Title 13 – Nature in Neighborhoods is intended to protect natural resources in urban areas but none of these opportunities are identified in the Plan for BFR south. The SWMP calls for protecting natural resources in subsections 1.1 Stormwater Master Plan Objectives and 2.2 Future Planning Areas. None of these opportunities are evaluated in the Plan for BFR south especially for the Basalt Creek Concept Plan area.

Comment LEA7. SWMP Figure 2-3 - Topography and Soils map contains too many TEXT overlays in the vicinity of Boones Ferry Road South of Norwood Road and the Lucini Property.

The sensitive steep slope topography in this vicinity can't be read. The "Boones Ferry" and "Basalt Creek" labels need to be moved from this visually important area of this map.

Comment LEA8. SWMP Table 2-1 (Page 2-3) in combination with Figure 2-3 - Topography and Soils suggests that infiltration is not a likely future runoff design solution in the BFR south. This is particularly important since this area is perched above steep slopes draining to Basalt Creek. This area is also above drinking water wells in the area including the Lucini property.

Comment LEA9. When the SWMP Appendix A - CIP Fact Sheets documentation is accessed for the Siuslaw Water Quality Retrofit, which includes the Alsea Road area (CIP17), there is no mention of infiltration in the design. But Table 3-1, Opportunity Area 6, aka CIP17, plainly refers to infiltration. The potential application of infiltration at the CIP17 site is of concern because it is inappropriate based on poorly draining soils (see next comment). As it relates to the BFR south area, applying the same inappropriate infiltration design approach will potentially cause significant problems (see next comment).

Comment LEA10. The BFR south area needs to exclude infiltration facilities as an alternative to reducing surface flow. Figure 7-1 (Page 3-2) does not show any CIP in the vicinity of BFR south although potential problems exist (see LEA Supplement B Part 2: Appendix A.2).

Comment LEA11. SWMP Figure 7-1 does show the location of CIP17, which is additionally described in Table 3-1 - City of Tualatin Stormwater Project Opportunities Number 6 as Alsea/BF Rd and 99th/Siuslaw Greenway. This CIP17 would drain to Hedges Creek and is comprised of "C" type soils as identified by Hydrologic Soil Group (see Section 2.4 -Soils, Table 3-1 and Figure 2-3). "C" type soils poorly drain and do not support functional infiltration facilities. The concern is that the "C" type soils above the Lucini property may be subjected to the same contradictory conclusion as the CIP17 site. This problem of misapplying design solutions may also exist for other conditions because BFR south has not been evaluated by Tualatin for hydrology and hydraulics as well as CIP.

Comment LEA12. SWMP Figure 2-6 - Stormwater System Overview omits the stormwater inlets, piping and other stormwater facilities in and around BFR south. The Stormwater Outfalls to the Basalt Creek Management Area and Greenhill Lane are not indicated (see LEA Supplement B Part 2: Appendix A.2). Downstream channels below the outfalls are not shown.

Comment LEA13. The SWMP Section 9 has incomplete References to Clean Water Services (CWS). The CWS document date and title are not current. For consistence in citing standards, the CWS reference must read "Design and Construction Standards" dated December 2019.

Comment LEA14. Nowhere in the Tualatin SWMP is a Stormwater Field Monitoring or Sampling program identified or proposed. This is despite the fact that Table 3-1 indicates numerous flooding and water quality problems resulting from stormwater flows. Table ES-1 – Capital Project Summary is being proposed without monitoring and sampling program basis.

Comment LEA15. There is no assessment of peak and average stormflows on the steep slopes, which constitute the west flank of the BFR south area. These Tualatin stormflows discharge to the Basalt Creek Concept Plan area and their existence is not established in the SWMP. Stormflows on these steep slopes have excessive peak and average flow velocities, which cause erosion (see Supplement B Part 1 Analysis Report Section 4. Stormflow Hydraulics and Part 2 Appendices A2 and I).

Comment LEA16. The Tualatin SWMP makes no provisions for temporary stormwater storage and discharge facilities when phasing-in large developments such as the Root property in BFR south. The concern is that arbitrary storage and discharge locations could occur in the interim, before the final stormwater facility is operable. It needs to be specified in the Tualatin SWMP that new construction developments must use stormwater facilities and outfalls consistent only with its final specifications and drawings.

Supplements

Supplements Contents

Supplement A

LEA Request for Tualatin SWMP Appendices

Subject:
Re: Review of Draft Tualatin SWMP by LEA
From:
Dave LaLiberte <dave@ee83.com>
Date:
12/10/2020 10:33 AM
To:
Hayden Ausland <hausland@tualatin.gov>
CC:
"grluci@gmail.com" <grluci@gmail.com>

Thanks Hayden.

The files downloaded just fine.

Dave

On 12/10/2020 10:05 AM, Hayden Ausland wrote:
> Good morning Dave,
>
> Due to large files sizes, I've had to upload the appendices to an online file sharing system. The appendices come in two separate files and I'm hoping both hyperlinks below will work for you. Please let me know if you have any issues or problems with accessing these files.
>
> - Appendices A-D: https://cityoftualatin-my.sharepoint.com/:b:/g/personal/hausland_tualatin_gov/EYCg3fA-dVpMrk_014xs9KwB0o-idA1Eo1MdnnKw6fufZw?e=u0CnNH
>
> - Appendices E-I: https://cityoftualatin-my.sharepoint.com/:b:/g/personal/hausland_tualatin_gov/ESQumWDmfCdGrAIq_nTWEgQBNGIFcmZuGrb670B-KzxMow?e=jwjpn9
>
> Regards,
>
> Hayden Ausland, EIT, CPSWQ
> Engineering Associate - Water Quality
> City of Tualatin
> P 503.691.3037 | C 971.978.8217
>
> -----Original Message-----
> From: Dave LaLiberte <dave@ee83.com>
> Sent: Thursday, December 10, 2020 8:55 AM
> To: Hayden Ausland <hausland@tualatin.gov>
> Subject: Review of Draft Tualatin SWMP by LEA
>
> Hi Hayden,
>
> I am an Engineer working with John and Grace Lucini reviewing the Draft Tualatin Stormwater Master Plan (April 2019). I need to obtain the Appendices that are referenced in the report but not included by the City in the report. These are:
>

>
> Please let me know at your earliest convenience when I may receive
these documents for my review.
>
> Thanks,
> David (Dave) LaLiberte, P.E.
> LIberte Environmental Associates, Inc. (LEA) WIlsonville, Oregon
> 503.582.1558
>

Supplement B: Part 1 – Analysis Report

Included under separate cover because of size.

Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property (LEA, November 2016)

Contracted by John and Grace Lucini, 23677 SW Boones Ferry Road, Washington County, Oregon, Tualatin, Oregon, 97140.
This report is referred to as the "Stormflow Analysis" throughout these comments.

Supplement B: Part 2 – Rpt Appendices

Included under separate cover because of size.

Appendices - *Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property* (LEA, November 2016)

Supplement C

CV for David M. LaLiberte, P.E.

David M. LaLiberte, P.E.
Principal Engineer

LEA

Summary:

Mr. LaLiberte's qualifications comprise over 30 years of experience in surface water quality analysis and evaluation, hydrology and hydraulics, stormwater system analysis, biological criteria for water and sediments, environmental quality control, sewage and industrial pollution abatement, effluent treatment alternatives and design, discharge requirements for NPDES wastewater and stormwater permits, mixing zone assessment, water intake and thermal discharges and environmental design. He has managed and performed on many environmental project teams assisting state and federal agencies, as well as municipal and industrial facilities, and non-governmental organizations in Oregon, California, Washington, Alaska and throughout the USA.

Education: M.S., Civil Engineering, Portland State University, 1990
B.S., Civil Engineering, Portland State University, 1988

Registration: Professional Engineer, Oregon (Civil and Environmental)

Liberte Environmental Associates, Inc. Experience:

Water Quality Evaluation of the Stormwater Management Plan (SWMP) Proposed for The Dalles, Oregon Wal-Mart Super Center for Karl Anuta, Attorney representing the plaintiff Citizens for Responsible Development in The Dalles. The effect on receiving water quality from stormwater discharges from a large retail facility was assessed in a report submitted to the Circuit Court of the State of Oregon. The detailed Expert Report was developed identifying the discharge conditions, storm flows based on local precipitation, storm flow mapping and routes, potential treatment levels using mechanical filtration and swales and other WQ issues. Water quality effects on receiving wetlands and tributaries of the Columbia River were investigated because of increased solids, toxics and bacterial loadings to be released from the proposed facility. Expert Testimony was provided in court supporting the evaluation report. This project was conducted in 2012 and 2013.

NPDES Mixing Zone and Water Quality Evaluations for Trident Seafoods Corporation, Alaska – Effluent characterization, discharge system configuration, receiving waterbody consideration, biological criteria and mixing zone evaluations were performed. Acting as subconsultant for Steigers Corporation. Facility operations generating wastewater discharges include: stormwater runoff inflow, seafood-processing wastewater, non-contact cooling water, treated sanitary effluent and other sources of industrial effluents. The MZ evaluations conformed to NPDES permit requirements and mixing zone guidelines for Trident facilities in Alaska at Akutan and Sandpoint. This project was performed from 2010 through 2012.

NPDES Water Quality Technical Assistance and Alternative Design Evaluations for North Slope Borough, Alaska – Evaluation of US Environmental Protection agency NPDES permit for discharges from oil and gas facilities including discharges from: stormwater system, drilling operations, cooling water intake and discharge, storage facilities, pipelines, gravel pits, treated sewage discharges, maintenance requirements, and other types of discharges. These discharges include stormwater affected deck drainage, cooling water intake and thermal discharges, treated sewage discharges and drill cuttings disposal to marine sediments. Water quality evaluation of the Camden Bay Exploration Plan for the Beaufort Sea of the Arctic Ocean was conducted for discharge impacts on the marine aquatic environment and relative to BOEMRE/MMS EIS. Analysis of the Chukchi Sea Exploration Plan of the Arctic Ocean was conducted for discharge impacts on the marine aquatic environment and relative to BOEMRE/MMS EIS. These evaluations were based on water quality and treatment alternatives assessment, and comparison to biological criteria. This project was conducted in 2010 through 2011.

Aurora STP NPDES Assessment for CRAG Law Center - Review of documents related to the design, operation and monitoring of the Aurora, Oregon Sewage Treatment Plant. Documents include: NPDES permit; stormwater inflow and infiltration, design related plans and specifications including recent headworks unit design; discharge monitoring reports, irrigation using effluent reuse, biosolids monitoring reports; effluent reuse plan and additional information relating to the design and operation of the Aurora STP. The review provided a basis for assessing potential causes of facility underperformance and discharge violations. An STP site visit was performed during this project to investigate facility aeration treatment, reuse equipment and capacities. This project was conducted from 2008 through 2010.

Review of the Medford STP Nutrient Related Discharges, for CRAG Law Center in Portland, Oregon. Evaluation of treatment facility and nutrient discharges from the Medford Sewage Treatment Plant (STP) into the Rogue River in Jackson County, Oregon. Existing discharges were evaluated for nutrient concentrations based on the discharger's CORMIX mixing zone analysis. Facility costs to upgrade for nutrient removal, including nitrogen and phosphorus, were developed. This project was performed in 2015 through 2017.

Evaluation of Sewage Treatment Plant Discharges to the Illinois River, Oregon, for the City of Cave Junction. Mixing zone analysis using EPA CORMIX was performed to determine the effects of temperature and other discharge parameters on river quality. Hydraulic analysis of river flow conditions was conducted to support the MZ analysis particularly for critical summertime conditions. This project was performed in 2013 through 2014.

Draper Valley Farms, Inc. Chicken Processing Industrial Discharge to Municipal Sewage System, for Smith and Lowney, PLLC representing the plaintiff Waste Action Project Citizens Suit. The effects on sewage treatment processes were evaluated relative to high biochemical oxygen demand (BOD) from Draper Valley Farms (DVF). A key focus of this analysis was the operational consequences of excess BOD on treatment in the aeration basins of the Mt. Vernon, WA municipal facility. The pass-through impact on the Skagit River was assessed for increased BOD from the industrial discharge. This project was conducted in 2014 and 2015.

Coal Discharge Investigation for the Columbia River and Selected Tributaries, for the Sierra Club supported by the Columbia Riverkeepers. Prospective coal samples were collected from sediments along 18 miles of the Columbia River located at the confluences of selected tributaries from Rock Creek (RM 150.0) to the White Salmon River (RM 168.3). Sampling locations corresponded to Burlington Northern Santa Fe (BNSF) railroad crossings at or near tributaries. The distribution of coal discharges into the Columbia River were mapped. Samples were analyzed by a third-party laboratory. Sample parameters were: moisture content, fixed carbon, volatile matter, ash and total sulfur. This was based on ASTM Proximate Analysis plus sulfur. Coal identification, to determine potential sources of coal, was completed for this investigation with the support of supplemental analysis advised by the laboratory. Supplemental analysis included ASTM D-388 requirements for heating value, sulfur in ash, free swelling index (carbonization physical characteristic) and classification of coal by rank. A deposition was provided in 2016 to defend the results of coal report. This project was performed in 2012 through 2013 and 2016.

Oregon Department of Environmental Quality - WQ Technical Assistance: Industrial discharge effluent evaluation of the Port of St. Helens, Oregon ethanol and power generating plants. Outfall mixing zone analysis with design assessment was developed. Provided water quality evaluation and environmental engineering assistance to the Oregon DEQ. Work included receiving WQ analysis, operations review, thermal discharge evaluation, biological criteria comparison and mixing zone analysis. NPDES requirements were based on EPA *Quality Criteria for Water*, EPA *Technical Support Document for Water-based Toxics Control* (TSD) and State Administrative Rules. The mixing zone models CORMIX and PLUMES were evaluated relative to the cases at hand. Potential discharge chlorine residual and temperature requirements were evaluated. The effect of potential temperature Total Maximum Daily Loads (TMDLs) in the Columbia River was also evaluated. This project was performed in 2003 through 2004.

Wauna Pulp and Paper Mill Outfall 003 and Columbia River Field Survey Locations and Sampling Results for Columbia Riverkeeper including sampling. In coordination with staff and volunteers, water samples were collected in the vicinity of the paper mill outfall for laboratory analysis. The physical outfall mixing zone was mapped using in-situ Hydrolab water quality measurements taken with depth for temperature, dissolved oxygen, pH, conductivity and turbidity. Laboratory samples were analyzed for potentially toxic concentrations of dioxins, total residual chlorine (TRC) and metals including aluminum, arsenic, copper, iron, lead, mercury and zinc. Additional information sources were investigated using the Oregon DEQ permit file and including the mill's NPDES permit and the mutual agreement and order (MAO) compliance schedule. This project was conducted in 2004.

Review of Draft and Final NPDES General Permit Cook Inlet, Alaska Oil and Gas Operators for Cook Inletkeeper - Evaluation of the draft National Pollutant Discharge Elimination System (NPDES) permit proposed by the U.S. Environmental Protection Agency (EPA) authorizing wastewater discharges from oil and gas exploration, development, and production facilities into Cook Inlet, Alaska. There are 18 existing facilities discharging into Cook Inlet with new facilities capable of being brought on line under the draft permit. Technical analysis of these discharges, which can contain toxic and bioaccumulating contaminants, was performed relative to the potential to adversely affect Cook Inlet water quality and sediments. This project was conducted from 2007 through 2009.

Water Quality Evaluations and NPDES Permit Requirements for the four (4) WES publicly owned treatment works (POTW) discharges (2000-2004, 1999) performed for Water Environment Services, Clackamas County, Oregon. These included evaluation of discharge effects on the Willamette River (2 outfalls), Sandy River and a tributary of the Clackamas River. Field water quality sampling including detailed outfall mixing zone investigations. Water quality assessment was conducted relative to effluent temperature, disinfection and ammonia requirements to protect fish and aquatic organisms. Effluent mixing zone simulation and analysis was performed. Treatment alternatives analysis and costing were undertaken to ensure existing and future discharge conditions were protective of river WQ. River outfall piping alignment and diffuser design was provided including construction management of river installation.

Expert Analysis of Surimi and Seafood Industrial Wastewater Discharge into the Skipanon and Columbia Rivers, Oregon (2003-2006) was conducted for the National Environmental Law Center. Water quality analysis evaluating the effects of seafood and surimi wastewater discharges on the Skipanon and Columbia Rivers, Oregon. Field data collection was performed to support water quality technical analysis. Investigation included mixing zone analysis of historic seafood and surimi wastewater discharges into the Skipanon River, and new discharges to the Columbia River. Evaluations were performed for various discharge scenarios, monitoring and sampling requirements, potential treatment options, and alternative outfall pipeline alignments. Effluent and instream dissolved oxygen (DO), biochemical oxygen demand (BOD), ammonia, hydrogen sulfide, nutrients nitrogen and phosphorus, oil and grease, and total suspended solids (TSS) were evaluated in detail. Expert witness analysis and reporting was provided.

Westport Sewer Service District, Clatsop County, Oregon - MZ Evaluation with Alternative Disinfection (2003-2004). This project assessed water quality and mixing zone effects of disinfected treated wastewater discharged to Westport Slough, a segment of the Columbia River. Chlorine residual reduction or elimination was a key evaluation concern to satisfy Oregon DEQ requirements. Comparisons of alternative disinfection treatment scenarios and costs were performed that would allow the discharger to continue to meet WQ requirements. Ultraviolet disinfection, chlorination-dechlorination, and outfall diffuser feasibility were all investigated with comparison costs. In particular, the existing chlorination system was evaluated relative to how easily it could be retrofitted to function with dechlorination. The alternatives analysis aided the discharger in making a determination as to course of action.

Public Employees for Environmental Responsibility preparation of report Effect On Puget Sound Chinook Salmon of NPDES Authorized Toxic Discharges as Permitted by Washington Department of Ecology (2005-2006). Industrial, municipal, stormwater and general facility NPDES permits were reviewed and analyzed relative to the presence of toxic contaminants in Puget Sound. Toxic contaminants evaluated included metals, hydrocarbons, and chlorinated hydrocarbons.

Citizens for Responsibility v. Izaak Walton League, Circuit Court of the State of Oregon for Lane County, Expert Analysis for Plaintiff evaluating the effects of lead contamination from shooting range into South Fork Spencer Creek (2004-2005). Sediment sampling was conducted for metals including lead, arsenic, copper and polynuclear aromatic hydrocarbons (PAH). This information was evaluated for pollutant distribution and transport from the contaminated site and relative to upstream and downstream properties. Expert testimony was given at trial in 2004. Expert analysis and testimony was also provided in the subsequent equitable relief phase. Participation in the settlement conference was also provided.

Canby Utility Board - Industrial Discharge from Water Treatment Plant Study and Predesign (1999-2000) addressing Molalla River water quality issues with Oregon DEQ including treatment alternatives: filter backwash sedimentation basin, disinfected effluent de-chlorination, river infiltration gallery design, intake piping system, and sediment and riparian effects mitigation.

Water Environment Services of Clackamas County Hoodland WWTP Outfall Project Descriptions and Costs (2000); FEMA engineering, budgeting and negotiations is intended to reimburse Clackamas County for flood damage to their wastewater treatment plant outfall on the Sandy River. Numerous regulatory issues affected costs including an ACE 404 permit for instream construction work, NMFS ESA Section 7 Consultation, and NEPA documentation including environmental and biological assessments.

City of Bremerton, CSO Projects --A comprehensive review of the City of Bremerton, Washington collection system model was performed (2000). Hydraulic modeling was used to update information for the main sewer lines, combined sewer overflows and discharge conditions. Selected CSO reduction alternatives were evaluated and implemented. The purpose of the CSO reduction alternatives was accomplished and potential early action projects were identified. These projects yielded substantial CSO reductions while being quickly implemented at reasonable cost. Revised CSO baselines were produced conforming to Washington Department of Ecology requirments for Bremerton's 17 CSO outfalls. Expert witness testimony supporting the findings of the CSO baselines was provided in a hearing at the Federal Court in Seattle.

Previous Experience (Montgomery Watson Americas)

In addition, I have performed as project manager and/or project engineer on the following undertakings:

- Project Manager/Engineer evaluating stormwater hydrologic, hydraulic and quality conditions in Balch Creek Basin for the City of Portland, Bureau of Environmental Services, Oregon. The Army Corps of Engineers (COE) hydrographic model, (HEC-1) and hydraulic model (HEC-2) were applied to establish design criteria for flood magnitude, stormwater detention, water quality facility hydraulics and fish passage culvert hydraulics.

- Project Engineer evaluating stormwater hydrologic, hydraulic and quality conditions in Clackamas County for the CCSD#1. The graphically enhanced model, XP-SWMM, was used to develop the hydrology and hydraulics for the Kellogg and Mt. Scott Creeks basins in CCSD#1.

- *City of Portland, Bureau of Environmental Services* included Water Quality Evaluations and Diffuser Designs (2000-2001, 1997,1994) for wet and dry weather flows with chlorine residual discharges, and wet weather stormwater runoff for suspended solids and metals with potentially affected agencies including US Corps of Engineers, Oregon Division of State Lands, NOAA Fisheries, Oregon Dept. of Fish and Wildlife and US Fish and Wildlife.

- Project Manager/Engineer for the Kensington Mine in Alaska. PLUMES mixing zone modeling was used to evaluate the conditions affecting this industrial outfall. Sedimentation basin design for removal of mine tailings prior to discharge to Lynn Canal.

- City of Bremerton Corrosion and Fluoridation Facility detention facility design. An on-site detention facility was designed pursuant to Washington Department of Ecology's requirements as specified in the *Puget Sound Stormwater Management Manual*.

- Project Engineer for Water Environment Services of Clackamas County Kellogg Creek WWTP Odor Control Project. Participated as team engineer to design malodorous air collection system for headworks, primary clarifiers, secondary clarifiers, and dissolved air floatation thickening (DAFT) building. Malodorous air was passed through a biofilter for treatment.

- Project Engineer for Crescent City, California WWTP outfall mixing zone analysis. A major consideration of this project was developing alternative outfall pipeline alignments and an effective discharge location to optimize mixing.

- Project Manager/Engineer for the Hoodland WWTP Outfall project, which includes outfall diffuser design and construction (1998) in a sensitive Sandy River corridor.

- Project Task Manager—Jefferson County (Birmingham, Alabama) stream water quality analysis was performed relating to recommended NPDES permit limits for dry and wet weather conditions. Collection system analysis and treatment plant design constraints are also considerations in this potentially very large project.

- Project Engineer using Pizer's HYDRA, data compatible with the City of Portland, Oregon's XP-SWMM format, to evaluate gravity flow conditions in the proposed dual outfall system consisting of two connected parallel outfall systems over one mile each and including wet weather (CSO) hydraulic structures such as flow control structures, mix boxes and outfall diffusers.

- *City of Madison, Wisconsin* - stream water quality modeling analysis of POTW discharge relative to NPDES permitting requirements (1995-1996). A key objective of this study was restoration of base flows to the Sugar River Basin using high quality POTW effluent. An EPA QUAL2E model was developed for Badger Mill Creek and the Sugar River. Physical, chemical and biological simulation included temperature, algae, dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended solids (TSS) and ammonia. Particular attention was focused on the inter-relationships between temperature, climatological conditions, stream shading and channel conditions, DO, BOD and algal activity. Temperature and discharge point design alternatives were investigated using the model. It was demonstrated that, with minimal WWTP facility upgrading and cost, the City could beneficially discharge high quality effluent to surface streams. This assurance was primarily accomplished through detailed modeling analysis and model approach consensus building with regulators (WDNR). Some keys to the success of this project were in identifying important NPDES permitting issues, evaluating them with the model, recommending permit effluent limits and negotiating with regulators.

- *Washington Beef, Incorporated* in Toppenish, Washington – Development of an NPDES permit under the direction of the EPA (1993-94). The project objective was development of receiving water based permit effluent limits for this food-products industry discharger using dissolved air floatation (DAF) treatment. Important project elements were: interfacing with regulatory (EPA Region 10 and Washington Ecology) and public agencies; evaluation of the effect of effluent parameters on receiving water using modeling analysis (EPA QUAL2E and EPA CORMIX); and providing long-term treatment system design recommendations. Fishery issues were of key concern for this project. Receiving water modeling was used to analyze the discharge effects of on stream dissolved oxygen and temperature on the aquatic environment. The inter-relationship between temperature, climatological conditions, stream shading and channel conditions, DO and algal activity were thoroughly investigated. Temperature and discharge design alternatives were evaluated using the water quality model.

Previous Experience (Other Firm)

- *Oregon Department of Environmental Quality and Oregon Department of State Land Conservation and Development* - Non-point Source Pollution Control Guidebook for Local Government (1994) evaluation of non-point runoff pollution and control measures including detention facilities, sedimentation basins, water quality ponds and marshes; City of Portland, Bureau of Environmental Services (1989-90) - evaluated effects of combined sewer overflows and stormwater discharges on the Columbia Slough of the Columbia River. Hydrologic and water quality modeling support was provided including sampling.

- Project Engineer for NPDES waste discharge permit review and support related to permit effluent limits for the City of Vancouver, Washington. Two tracer dye studies were performed at their two municipal WTP outfalls. The key project objective was to determine actual outfall dilution and provide a physical, receiving water basis for setting permit effluent limits. The mixing zone evaluations showed that actual dilution was greater than estimated by the regulatory agency (Washington Department of Ecology) and higher permit effluent limits were recommended.

- Project Task Manager and Engineer for a comprehensive hydraulic and water quality compliance evaluation and recommendations. The City of Portland's Columbia Boulevard WTP, the largest municipal discharger in Oregon (300 MGD), required assistance in meeting their water quality compliance needs. A highly detailed Columbia River tidal flow evaluation was performed in the outfall vicinity to serve as the basis for the mixing zone simulation and diffuser design. EPA CORMIX, and the EPA supported PLUME model family (including UDKHDEN), were used in the modeling analysis. A thorough investigation of water quality compliance options led to regulatory (ODEQ) approval of the multi-port diffuser design, the lowest cost compliance option.

- Project Engineer for Kehei, Hawaii Water Reuse Facility (1992). Participated as team engineer to design upgrades to the facility's aeration basin including aeration blower design and aeration basin air piping with small bubble diffusion.

- Project Engineer for the Columbia Slough flow augmentation project for the City of Portland Bureau of Environmental Services, Oregon. Dynamic water quality modeling (COE CE-QUAL-W2), water quality sampling, and hydrodynamic sampling were performed for this dynamic "freshwater" estuary. This project was driven by the City's need to evaluate the impact of water quality limited conditions on the Columbia Slough and was coupled to the City's EPA SWMM model. The objective was to propose best management practices (BMP) and evaluate design alternatives. The effect of temperature on the aquatic environment was examined in detail. The sophisticated two-dimensional (vertical and longitudinal) dynamic model evaluated temperature regimes and their effect on in-stream water quality. In-stream temperature design alternatives were investigated via simulation of climatological conditions, stream shading and channel conditions, algal processes and kinetics, and instream DO.

- Project Engineer conducting stormwater hydrologic and hydraulic simulation to evaluate flood effects for the City of Beaverton, Oregon. HEC-1 hydrographic modeling was conducted to generate peak flow values from surface runoff for existing and future conditions. HEC-1 model results for 2, 5, 10, 25, 50 and 100-year storm events were supplied to the HEC-2 model for detailed hydraulic analysis. The HEC-2 modeling was required as part of a cost assessment that included potential flood damage of key storms.

- Project Manager and Engineer for a mixing zone evaluation and diffuser design for the City of Albany, Oregon. An outfall pipeline and 40 MGD capacity multi-port diffuser was designed for this municipal discharger using EPA CORMIX. Simulation was performed to optimize the diffuser design. The DEQ approved design will meet water quality compliance needs for chlorine and ammonia.

- Project Engineer mixing zone modeling and design for the City of Gresham, Oregon. Alternative disinfection and multiport diffuser design were evaluated. Modeling (EPA CORMIX) was utilized to optimize multiport diffuser design for this WWTP outfall. Simulation offered the flexibility to test numerous design conditions.

- Project Manager and Engineer for a mixing zone evaluation and diffuser design for the Unified Sewerage Agency, Washington County, Oregon. Analysis of four municipal treatment facility outfalls was conducted according to DEQ NPDES requirements. Model simulation was performed to determine revised wet weather chlorine residual effluent limits. The models were calibrated to dye study results. Wet weather stream surveys were also performed at two sites, Hillsboro and Forest Grove. Alternative disinfection was evaluated and diffuser design recommendations were also made.

- Project Manager and Engineer for outfall mixing zone simulation and water quality compliance evaluation for the Oak Lodge Sanitary District, Oregon. As part of NPDES permit requirements, model simulation was performed to characterize the municipal discharge-mixing zone. Available dilution values and recommended permit effluent limits for chlorine, ammonia and metals were derived from the study.

- Project Manager for a mixing zone evaluation and diffuser recommendations for Electronic Controls Devices, Incorporated. A mixing zone field evaluation of this circuit board manufacturer's discharge was performed. Very low amounts of organics and metals from the facility discharge needed to be discharged to a small stream in a responsible manner. This study illustrated that the discharge was well within compliance requirements.

Previous Experience (Portland State University Research Assistant)
City of Portland, Bureau of Environmental Services (1989-90) - evaluated effects of combined sewer overflows and stormwater discharges on the Columbia Slough of the Columbia River. Hydrologic and water quality modeling support was provided including field sampling.

- Project Engineer for evaluation of fish screen approach velocities and hydraulic design analysis for the Eugene Water and Electric Board, Leaburg, Oregon. The effects of downstream baffles on velocities through fish screens at the Leaburg Power Canal Facility were evaluated for fish passage.

- Project Engineer evaluating combined sewer overflows (CSO) and stormwater discharges on the Columbia Slough. Hydrologic and water quality modeling, using the City's EPA SWMM model data, of urban runoff from sub-basins discharging to the Columbia Slough was supplied as input to the Army Corps of Engineers in-stream surface water model, CE-QUAL-W2. This study was performed for the City of Portland, Bureau of Environmental Services in Oregon.

- Project Engineer for the South Slough National Estuarine Reserve Hydrodynamic and Water Quality Study, State of Oregon, Division of State Lands, Charleston, Oregon. Dynamic water quality modeling, water quality sampling, and hydrodynamic sampling were performed for this southern section of the Coos Bay estuary. Tracer (rhodamine) dye study results were used to calibrate the Army Corps of Engineers CE-QUAL-W2 model.

- Project Engineer for design of stream flow measurement structures on two tributaries of the South Slough National Estuarine Reserve (State of Oregon, Division of State Lands) in Charleston, Oregon. Analysis and design of stream flow measurement structures was required as part of a study assessing the hydrology and hydraulics of this pristine estuary.

- Project Engineer for a hydrologic, hydraulic and water quality assessment of Smith and Bybee Lakes in Portland, Oregon. Lake sampling and modeling was performed. The objective of the study was to evaluate the potential for water quality impairment due to the close proximity of St. John's municipal landfill and Columbia (North) Slough inflow. A hydraulic model of possible flow control structures was incorporated into the Army Corps of Engineers CE-QUAL-W2 hydrodynamic and water quality model. Recommended actions were advanced for improving lake water quality based on simulation scenarios. This study was conducted as part of a larger study for the Port of Portland, Metropolitan Service District, and City of Portland, Bureau of Environmental Services, Portland, OR.

- Project Manager and Engineer assessing the water quality impact of urban runoff from the Leadbetter storm outfall discharge to Bybee Lake. This study was conducted for the Port of Portland, Portland, Oregon.

- Project Engineer assisting in initial field work and model development for assessing impact of landfill leachate on surrounding surface waters. Conducted for the Metropolitan Service District (METRO) as part of the St. Johns Landfill closure.

Publications and Presentations

Stream Temperature Trading, Presented at the Pacific Northwest Pollution Control Annual Conference, 2001, Bend, Oregon.

Winter Temperature Gradients in Circular Clarifiers (January 1999), *Water Environment Research*, **70**, 1274.

Wet Weather River Diffuser Port Velocities: The Energetic Debate, Presented at the Pacific Northwest Pollution Control Annual Conference 1998, Portland, Oregon.

Near Field Mixing and Regulatory Compliance Implications Presented at Portland State University, February, 1998.

Whither the Wet Weather Flow, Presented at the Pacific Northwest Pollution Control Annual Conference 1997, Seattle, Washington.

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Contracted by John and Grace Lucini, 23677 SW Boones Ferry Road, Washington County, Oregon, Tualatin, Oregon, 97140.
This report is referred to as the “Stormflow Analysis” throughout these comments.

Effects of SW Boones Ferry Road Construction (2013-2015)

Stormflow Analysis for the Lucini Property
Washington County, Oregon

Prepared for
John and Grace Lucini
23677 SW Boones Ferry Road
Tualatin, Oregon
97140

REGISTERED PROFESSIONAL ENGINEER
18,645
OREGON
JULY 20 1993
DAVID M La LIBERTE

Prepared by
Dave LaLiberte
Principal Engineer
Liberte Environmental Associates, Inc.
Wilsonville, Oregon

LEA

November 1, 2016

1. Summary

Beginning in about 2015, Washington County, Oregon re-routed and increased the portion of stormwater flows passing through its road culvert (Outfall #5). These increased stormflows are associated with the County's SW Boones Ferry Road (BFR) Improvement Project. A location map is presented in Figure 1 showing the Lucini property relative to the County's road project. The re-routed portion and increased stormwater ultimately discharge onto the Lucini property[1]. Figures 2 and 3 show the stormwater conveyance through the steeply sloped Lucini property, which is composed of pipes and ditches. The photos in Appendix A document drainage condition problems on the Lucini property associated with the road project.

Increased portions of stormflows are now routed to the Lucini property but the County did not acknowledge this condition in its planning document, which is identified throughout this report as the *Drainage Report* (2013).[2] Figure 4 shows the erroneous subbasin boundaries used by the County in its Drainage Report. Figure 5 shows the necessary corrections to the faulty subbasin boundaries. These corrected subbasin boundaries demarcate a smaller actual subbasin acreage draining to the Lucini property, which results in lower stormflows than those projected by the County for ORIGINAL conditions prior to 2013. Appendix B provides the Drainage Report figures pertaining to overall subbasin boundaries for "Existing Conditions Hydrology", called throughout this report as the ORIGINAL conditions; and the "Proposed Conditions Hydrology", i.e., IMPLEMENTED conditions.

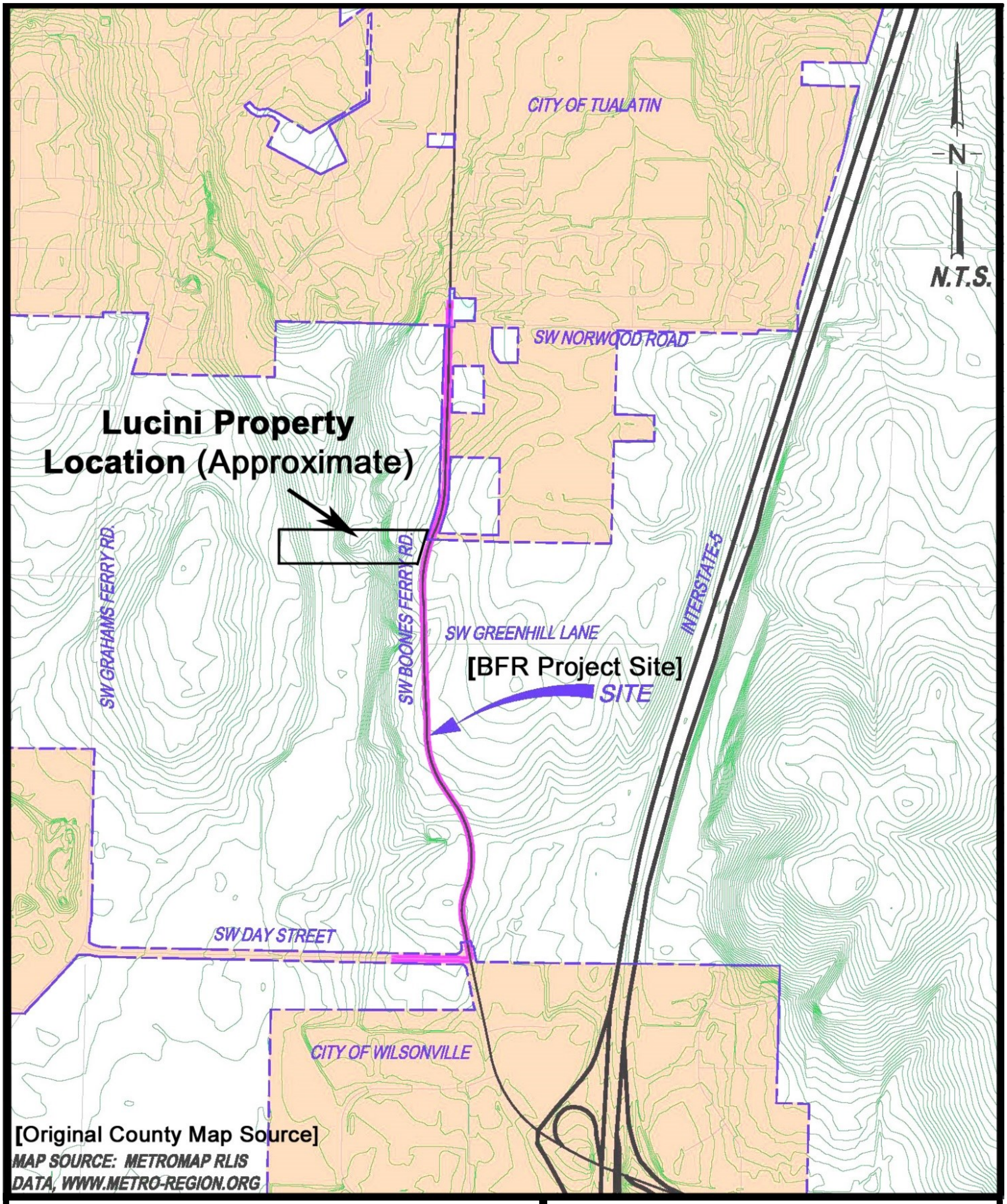
Photos and Drawings Documentation

The County claims in the Drainage Report that the ORIGINAL Boones Ferry Road above the Lucini property prior to 2013 was curbed and included storm sewers. However, the photos in Appendix A1 show that there are no curbs or storm sewer inlets. The County's mischaracterization of stormflow conditions, and depriving the public of accurate land contour information, allowed the County to shift a portion of flows from the adjacent and sensitive Greenhill Lane subbasin and into the subbasin above the Lucini property generating significant problems with erosion and flooding.

Appendix C contains the "Existing Conditions Plan" (June 2012) from the County's 70 percent drawings submittal related to the subbasin above the Lucini property. The drawings contain no elevation labeling nor do the unlabeled contour lines support the County's claim that the majority of stormflows in this area originally ended up passing onto the Lucini property.

[1] John and Grace Lucini property is located at: 23677 SW Boones Ferry Road, Tualatin, Oregon, 97140.

[2] Drainage Report (2013), Storm Drainage Report – SW Boones Ferry Road (SW Day Road to SW Norwood Road, by MacKay Sposito for Washington County, Capital Project Management (CPM), Final January 31, 2013.



Background Image from Washington County's *Storm Drainage Report for SW Boones Ferry Road* Appendix A2 - Site Map figure on PDF page 27 of 152 (January 31, 2013).

Figure 1. Location Map Showing Lucini Property Overlay and Proximity to the SW Boones Ferry Road Improvement Project

These problems were not corrected in the construction plans for the project related to the subbasin above the Lucini property as shown in the final as-built drawings (November 2014) available in Appendix D. The County's "Erosion and Sediment Control Plan" from the as-built drawings as it relates to the subbasin draining to the Lucini property are contained in Appendix E. These drawings show that the original contours allowed stormflow to enter the road right-of-way and then flow south into the adjacent Greenhill Lane subbasin, not the subbasin draining into the Lucini property.

The storm flow increases overwhelmed the existing downstream conveyance system causing substantial erosion and flood damage to the property in May 18, 2015. Photos of flood damage are presented in Appendix A2. Still more flood damage is threatened in future years as the County has not protected the Lucini property from increased flows in an area that is rapidly urbanizing. Appendix A3 contains photos of erosion damage on the Lucini property resulting from increased stormflows that erode soil, widen the conveyance ditch into the adjacent embankment and expose tree roots.

In its Drainage Report, the County has departed from its stated stormwater guidance identified in Clean Water Services (CWS).[3] In particular, the County did not carry-out a Downstream System[4] evaluation for the Lucini property as necessitated in its guidance. This evaluation process is used to determine the potential effects of increased storm flows on the property. The effects of ongoing and future development in the drainage above the Lucini property are neglected in the County's Drainage Report for the ORIGINAL (pre-2013) and IMPLEMENTED (2015) subbasin conditions.

The County disregarded increased stormflow effects, above the Lucini property, resulting from more intense ongoing and future urbanization in the subbasin. Near-term increases in land use intensity were also neglected as the Drainage Report did not acknowledge the County's own construction impact on the subbasin above the property. Increased stormflows, generated from the more intensely urban "Institutional" category associated with the City of Tualatin, are entirely overlooked by the County.

Purpose of this Stormflow Analysis

This Stormflow Analysis report is performed in lieu of Washington County carrying-out an accurate assessment of ORIGINAL (prior to 2013) and IMPLEMENTED (2015) drainage conditions upstream and through the Lucini property.

The U.S. Army Corps of Engineers (Corps) model, HEC-HMS[5], is used in this analysis to evaluate rainfall hydrology. Model inputs include precipitation time distributions and amounts, drainage area sizes, land use and soil conditions, runoff time-of concentration,

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[3] CWS (2007), *Design and Construction Standards for Sanitary Sewer and Surface Water Management*, for Clean Water Services (CWS), Hillsboro, Oregon, June 2007.

[4] Ibid, see Chapter 2, Page 12 under the 2.04.2 subsection heading "3. Review of Downstream System", i.e., this is subsection 2.04.2.3.

[5] HEC refers to the U.S. Army Corps of Engineers Hydrologic Engineering Center; and the HMS refers to the Hydrologic Model System.

stormwater routing and other parameters are considered for evaluating storm flows onto and through the Lucini property.

The hydrologic analysis performed in this report was first adjusted to the Washington County hydrologic results presented in its Drainage Report for the corresponding Soil Conservation Service (SCS) Type IA 25-year design storm. Then the corrected subbasin areas and land use conditions were supplied to the HEC-HMS hydrologic model so that realistic storm flow conditions could be simulated.

The County's Drainage Report did not perform a hydraulic analysis to assess the effects of stormflows above and through the Lucini property. The Corps hydraulic model, HEC-RAS[6], is used in this analysis to overcome the lack of hydraulic information. Peak flows from 25-year rainfall runoff, generated by the hydrologic model HEC-HMS, are supplied as inputs to the HEC-RAS hydraulic model. HEC-RAS is run in steady state mode, i.e., peak stormflows are held constant for each run. This process allows for the consideration of the impact of stormflows on piping, ditches and other features of the drainage system. Specifically, the hydraulic effects resulting from stormflows passing through the drainage system subbasins, stormflow routing, ditches, culverts (piping), land use conditions, ditch and piping materials, and other parameters can be assessed.

Hydrologic Modeling Results

The hydrologic simulation inputs and stormflow results generated by HEC-HMS for the subbasin above the Lucini property are contained in Appendix H.

The hydrologic modeling considered a number of probable realistic cases unexamined in the Drainage Report for the 25-year design storm. The ORIGINAL subbasin configuration as depicted in Figure 4, which is corrected as shown in Figure 5. The hydrologic model was then run with the more accurate drainage area as the ORIGINAL subbasin configuration. This comparison demonstrates that the realistic (actual) peak flow value of 0.89 cubic-feet-second (cfs) discharging to the Lucini property is 31.5 percent less (see the Figure 6 column chart) than peak flow of 1.17 cfs claimed in the County's Drainage Report. This is critically important because the County is inflating the ORIGINAL stormflows and makes it seem like the ORIGINAL condition had higher flows. This is an adverse condition for the Lucini's because the Drainage Report analysis later claims to reduce the ORIGINAL stormflow amount that it previously inflated as part of the IMPLEMENTED project.

Stormflow values are graphically compared in the Figure 6 through Figure 8 column charts. Figures 9 and 10 show the subbasin boundaries for IMPLEMENTED conditions, which permanently re-rout stormflows from a portion of the Greenhill Lane subbasin ultimately onto the Lucini property

Still greater stormflow inaccuracies are introduced by the County because it did not consider fundamental increases in impervious land areas resulting from ongoing and future land use. This is a basic necessity identified in the CWS (2007) guidance, which

[6] HEC-RAS refers to the River Analysis System hydraulic model developed by the Corps.

the County is claiming it is relying upon. It can be seen that ongoing land use and future full build-out development conditions result in much larger stormflows being discharged to the Lucini property.

Ongoing land use considerations include road construction activities and large facility support conditions necessitated by the Horizon Community Church. These land use conditions can be seen in the aerial view presented in Figures 13 and 14. Appendix F also displays additional land use characteristics in the subbasin above the Lucini property. Road construction activities result in soil compaction from heavy equipment movement and parking as well as materials staging and other provisions necessitated by road construction. Figures 13 and 14 also show the sprawling Horizon Community Church complex that relies in part on the subbasin draining to the Lucini property. The church facilities include a driveway, service roads, vehicle parking, facility support buildings and other impervious features affecting runoff.

When realistic ongoing land use is considered, stormflows discharged to the Lucini property are projected to inflate to 92.1 percent of the ORIGINAL conditions (see middle column in Figure 7). When stormflows from ongoing land use are compared to IMPLEMENTED conditions, the Lucini property is projected to receive 204.7 percent of the realistic (actual) original stormflows based on implemented conditions (see middle column in Figure 8).

The majority of the subbasin above the Lucini property is slated for intense future development allowed within the 20-year future development (FD20) planning. The County disregarded this condition in its Drainage Report and is subjecting the Lucini property to significant burdens from future erosion and flooding. When realistic future full build-out development is considered, stormflows discharged to the Lucini property are projected to inflate to 220.2 percent of the ORIGINAL conditions (see right column in Figure 7). When stormflows from full build-out conditions are compared to IMPLEMENTED conditions, the Lucini property is projected to receive 414.1 percent of the realistic (actual) original stormflows based on implemented conditions (see right column in Figure 8).

Hydraulic Modeling Results

The hydraulic modeling presented in this analysis evaluates the ORIGINAL and IMPLEMENTED piping and ditches on the Lucini property (see Figures 2 and 3) as well as the County's system above the Lucini property (see Figures 11 and 12).

Figure 11 shows the hydraulic conditions for connecting piping and the original road culvert locations for the ORIGINAL configuration. Figure 12 illustrates the IMPLEMENTED hydraulic conditions consisting of connecting piping and the new culvert comprising the County's Outfall #5. Figure 12 also shows the juxtaposition of the old and new Boones Ferry Road that hydraulically affects flows to the Lucini property.

The hydraulic simulation inputs and results, including stormflow water surface profiles and velocities, generated by HEC-RAS are available in Appendix I. The hydraulic modeling assessing pipe and ditch flow conditions shows that excessive stormflow velocities are created on the steep slopes of the Lucini property. The estimated land profiles of the storm water conveyance is illustrated in Figure 15 and Appendix I).

Stormflow velocities shown in Figure 16, for a range of land use conditions and the ORIGINAL subbasin configuration, demonstrate many instances where values exceed velocities that cause erosion on the Lucini property. These velocities exceed 4.0 feet-per-second (fps) and cannot be maintained. This deleterious situation requires measures to reduce peak flows coming through the County's culvert (Outfall #5) and onto the Lucini property. The physical conditions of excessive and increased streamflow on steep slopes existing on the Lucini property, and compared to the ORIGINAL conditions, were not evaluated by the County in its Drainage Report.

Stormflow velocities shown in Figure 17, for a range of land use conditions and the IMPLEMENTED subbasin configuration, demonstrate that values exceed velocities that cause erosion on the Lucini property for the ongoing land use and full build-out development conditions. These velocities exceed 4.0 feet-per-second (fps) and cannot be maintained. This harmful condition requires methods to reduce peak flows, including sediment and debris transport, passing through the County's culvert and onto the Lucini property. The physical conditions of excessive and increased streamflow on steep slopes existing on the Lucini property, and compared to IMPLEMENTED conditions, were not evaluated by the County in its Drainage Report.

Planning Level Costs
Three levels of estimated capital costs are related to remedying problems on the Lucini property resulting from the County's SW Boones Ferry Road widening project:

1) Immediate Shorter Term Remedy using Orifice Plate ($4,500 to $6,500 installed)
2) Ongoing Flow and Water Quality Control Facilities ($12,157 to $17,560 installed)
3) Longer Term Detention/Retention Facilities (to several hundred thousand dollars)

These capital costs include equipment, materials, labor, and construction contractor overhead and profit. Design, engineering and construction management costs are separately considered. An estimate of 20 percent of the final construction capital cost for this relatively small scale project is considered. For the high range estimates above, the design cost estimates are $1,300 for number 1 and $3,572 for number 2.

Notes:
[1] Background aerial image source from 2012-04-02 Map Boones Fry Rd FINAL_ EXHIBIT_AERIAL WA County.pdf. Five (5)-foot contours overlaid from 2013 Boones Ferry Road Wetlands and Contours from Metro Data Resource Center.
[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).
[3] Original Connecting Piping, about 42-foot long, 15-inch corregated metal pipe (CMP). Overlay from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

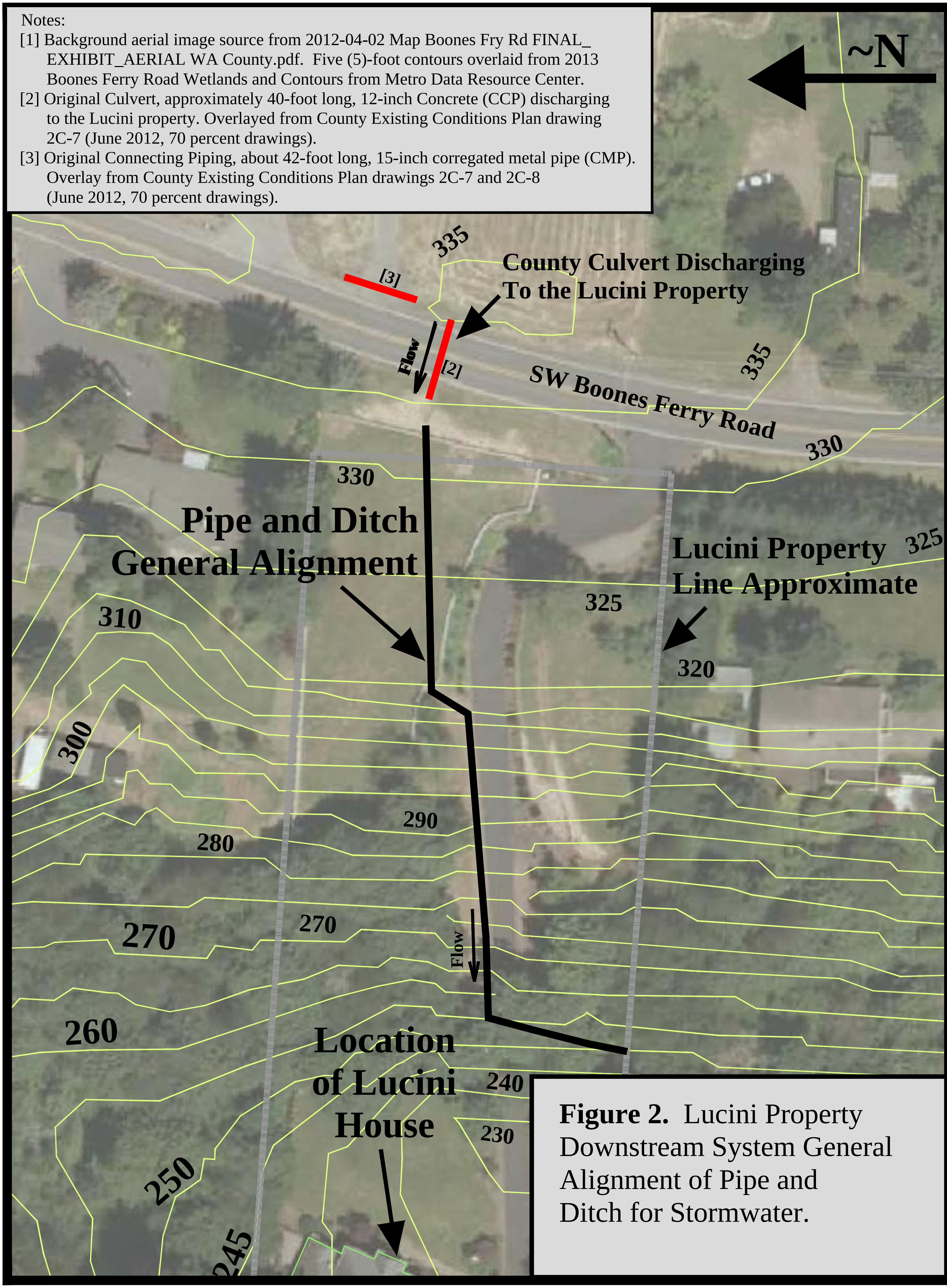


Figure 2. Lucini Property Downstream System General Alignment of Pipe and Ditch for Stormwater.

Notes:
[1] Background aerial image source from 2012-04-02 Map Boones Fry Rd FINAL_ EXHIBIT_AERIAL WA County.pdf. Five (5)-foot contours overlaid from 2013 Boones Ferry Road Wetlands and Contours from Metro Data Resource Center.
[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).
[3] Original Connecting Piping, about 42-foot long, 15-inch corregated metal pipe (CMP). Overlayed from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

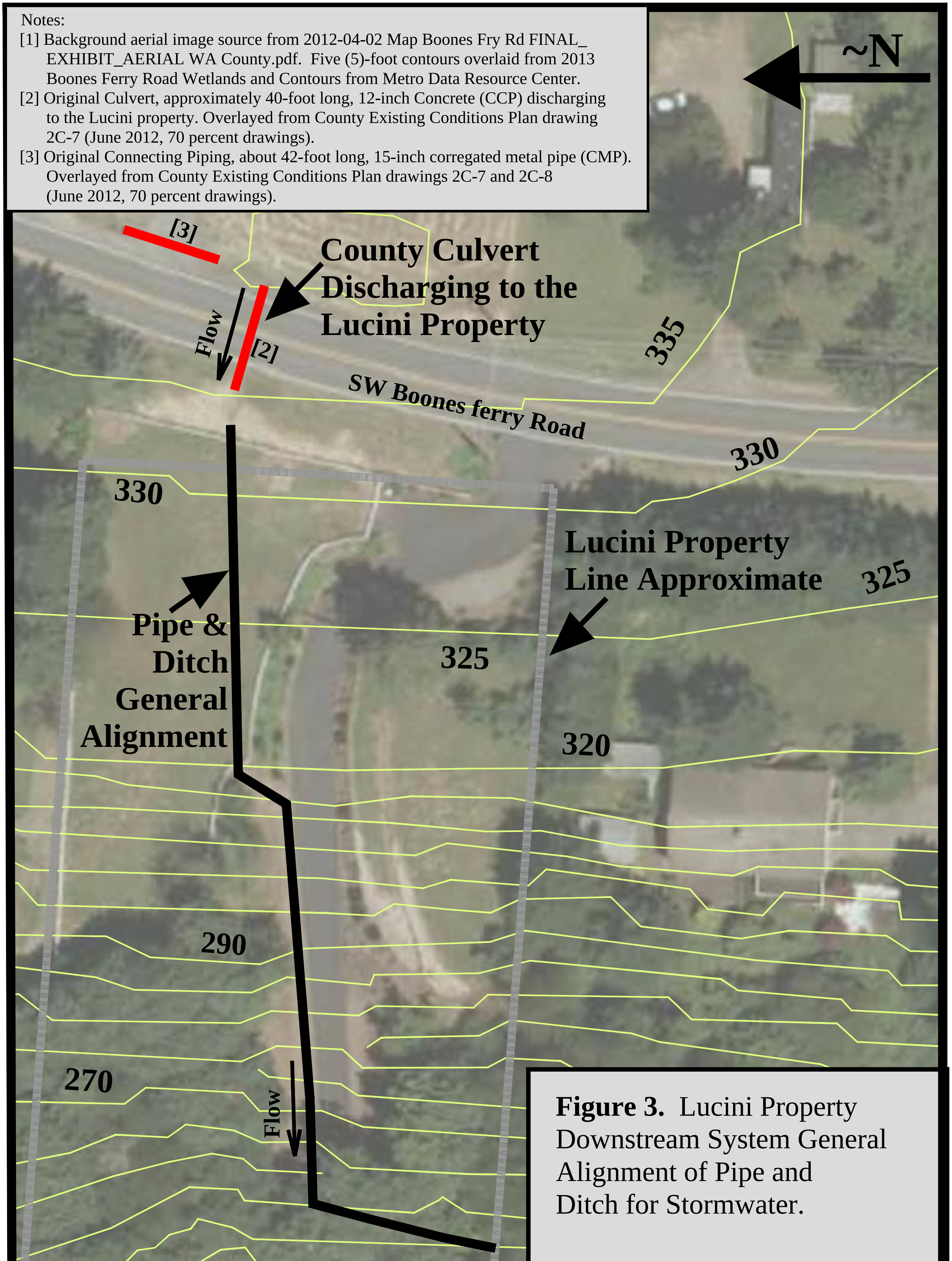


Figure 3. Lucini Property Downstream System General Alignment of Pipe and Ditch for Stormwater.

2. Background

This investigation begins with the ORIGINAL subbasin (Figures 4 and 5) stormflow conditions affecting the Lucini property and resulting from the SW Boones Ferry Road improvements project (approximately years 2013-2015). Unlike the County's Drainage Report (2013) that only considered very limited runoff hydrology, this study includes comprehensive stormflow hydrology and hydraulics comprised of the pipes and ditches upstream of, and on, the Lucini property.

Hydrology and Hydraulics

The hydrologic analysis performed in this report employs the U.S. Army Corps of Engineers (Corps) model called HEC-HMS.[7] The LEA model analysis was adjusted to the Washington County results for the initial corresponding design storm. The same Soil Conservation Service (SCS) design storm event[8] was used for both the Washington County and the LEA hydrologic analysis presented in this report.

The Washington County storm flow results affecting the Lucini property are compared in Tables 2 and 3, and are based on the SCS 25-year design storm event for ORIGINAL and IMPLEMENTED stormflow conditions, respectively.

For Original conditions, the County stated a peak storm flow of 1.17 cubic-feet-per-second (cfs) for the design storm event. The LEA hydrologic model analysis employing HEC-HMS produced the same storm flow results as the County. This LEA-County results calibration used the same model inputs as the County[9], for the supposed ORIGINAL drainage area, runoff curve numbers, and other corresponding parameters.

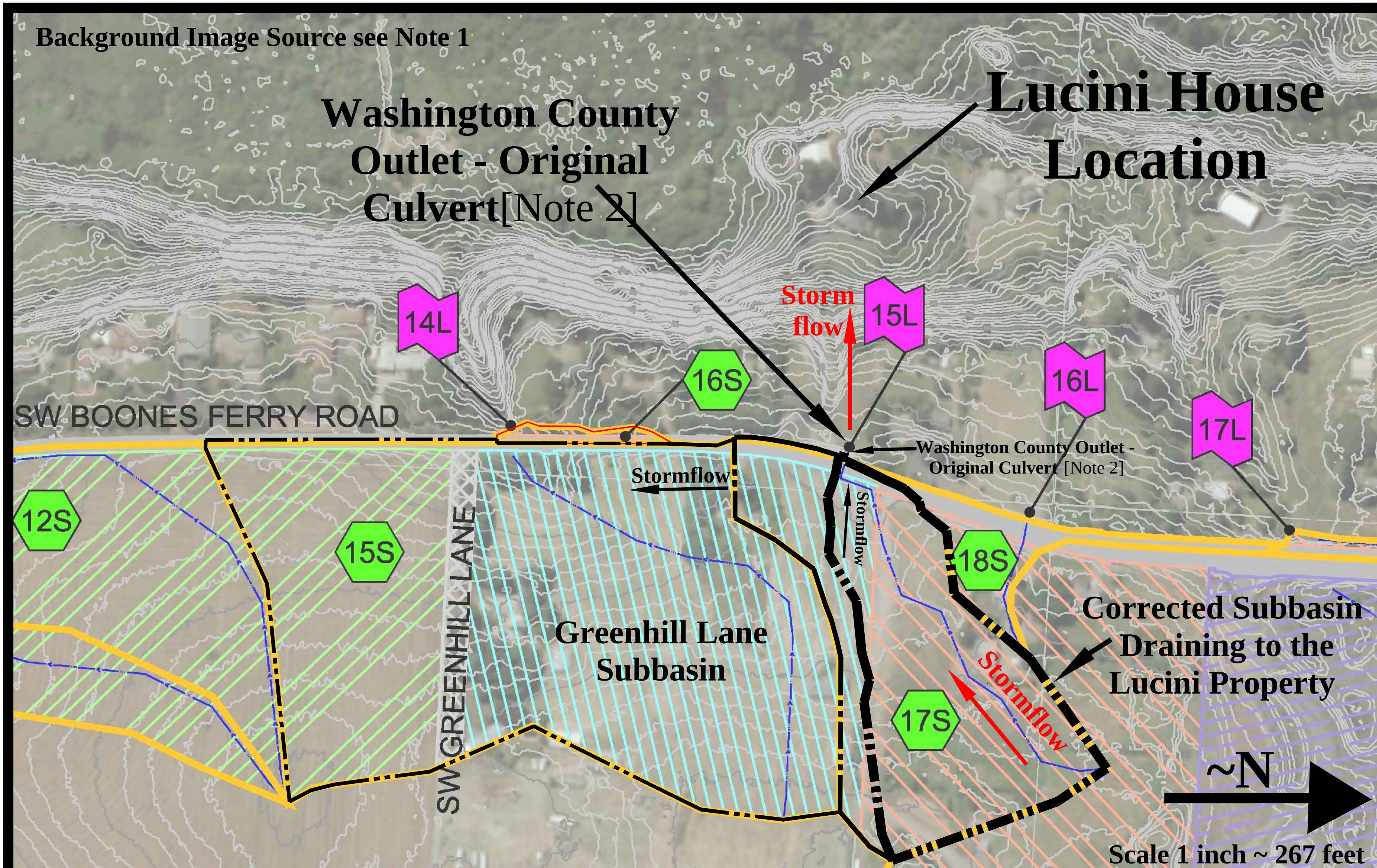
For IMPLEMENTED conditions, the County projected a peak storm flow of 0.85 cfs for the design storm event. The LEA hydrologic model analysis, employing HEC-HMS, produced the same storm flow results as the County. This LEA-County results calibration used the same inputs for the Implemented drainage area, runoff curve numbers, and other corresponding parameters.

Photos of the Lucini Property taken during the May 18, 2015 storm event are shown in Appendix A2. These photos demonstrate the excessive flow velocities generated at the site for storms even less than the 25-year event.

[7] HEC refers to the U.S. Army Corps of Engineers Hydrologic Engineering Center. HMS refers to the Hydrologic Model System.

[8] The design storm is defined herein as the 24-hour, 25-year Type IA developed by the Soil Conservation Service (SCS). This the same design storm event as used by Washington County in its Drainage Report.

[9] The County employed the commercially available HydroCAD software program to carry out the hydrologic calculations using the SCS design storm method.



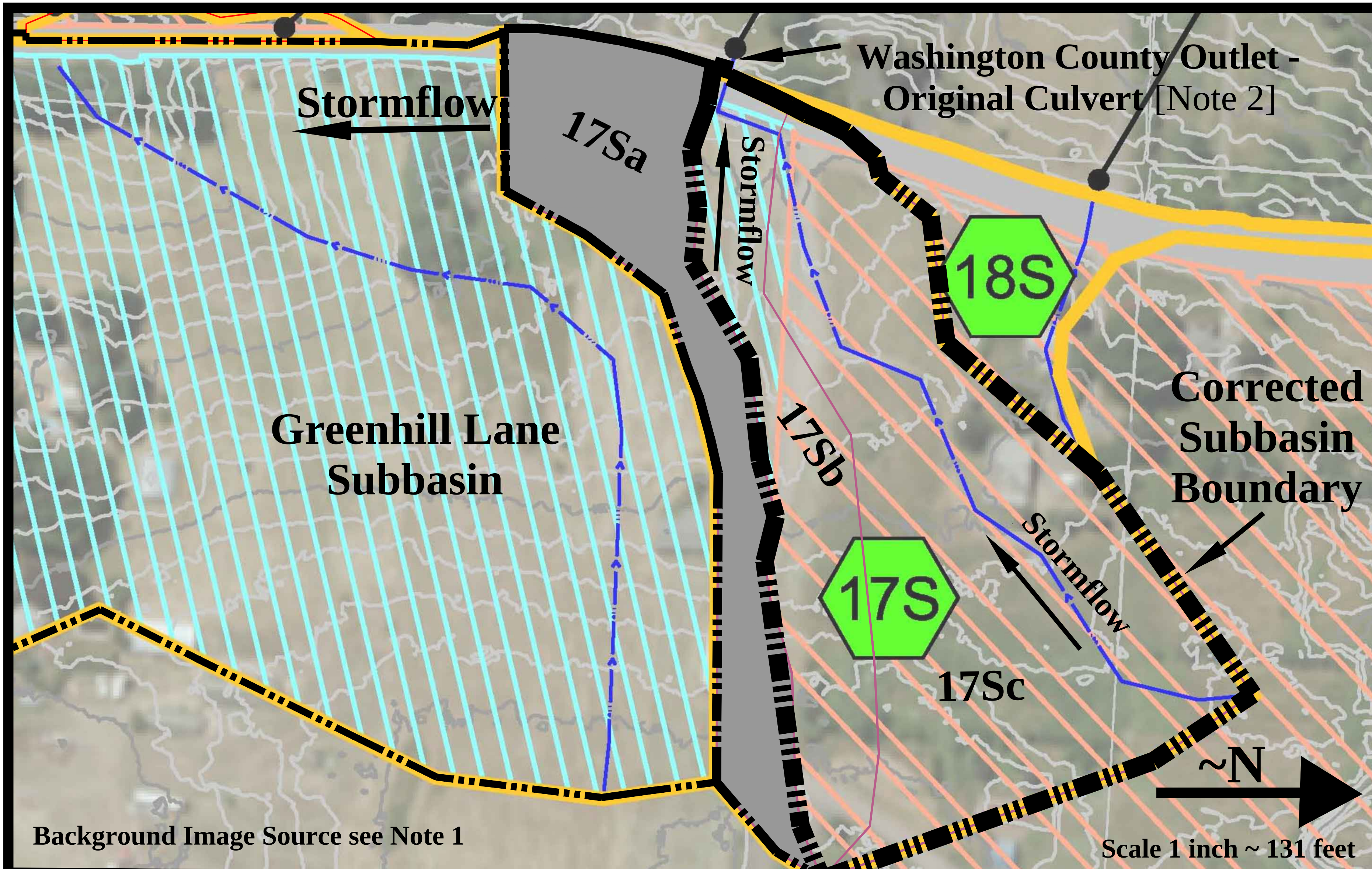
Notes:

[1] Background image source from Washington County *Storm Drainage Report* (January 2013), Existing Conditions Hydrology Map on PDF Page 35 of 152.

[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

[3] Original Connecting Piping, about 42-foot long, 15-inch corregated metal pipe (CMP). Overlayed from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

Figure 4. Original County Subbasins - Erroneous Boundaries for Drainage above the Lucini Property.



Notes:

[1] Background image source from Washington County *Storm Drainage Report* (January 2013), Existing Conditions Hydrolgy Map on PDF Page 35 of 152.

[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

[3] Original Connecting Piping, about 42-foot long, 15-inch corregated metal pipe (CMP). Overlayed from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

Figure 5. Original County Subbasins - Erroneous Boundaries for Drainage above the Lucini Property. (Close-in View)

The County's Drainage Report (2013) indicates it is relying upon CWS 2007 for storm flow evaluation methodology, which requires a "Review of Downstream System"[10], especially when flow increases are likely under present and future conditions. No Downstream System review exists in the Drainage Report for the storm water culvert flow draining to the Lucini property.

Despite supposed lower stormflows based on erroneous sub-basin delineation and land use conditions being reported in the Drainage Report[11], the storm inlet capacity for the culvert has been substantially increased. Stormflows are now conveyed to the storm inlets, and hence onto the property, much more rapidly than prior to the Boones Ferry Road widening project. This problem will worsen in the future because the Drainage Report and construction design did not take into account the future effects of full build-out conditions.

Flooding problems at the Lucini property are additionally aggravated because existing and future development conditions were disregarded in the Drainage Report. As CWS 2007 standards require:[12]

> 5.05 Storm Conveyance Design Considerations
>
> 5.05.1 Design for Full Build Out
>
> Storm drainage facilities shall be designed and constructed to accommodate all future full build-out flows generated from upstream property.

The Drainage Report did not evaluate the full build out stormflow conditions that will affect the property. Increased discharges from future development, routed through the County's road culvert, will result in worse flooding than presently exists.

[10] CWS 2007, see Chapter 2, Page 12 under the 2.04.2 subsection heading "3. Review of Downstream System", i.e., this is subsection 2.04.2.3.

[11] See Drainage Report on Page 11, Table under heading 5.5 - Hydrologic Analysis Results. Specifically, see the table results for Discharge Location 15L that indicates a reduction in stormflows.

[12] CWS 2007, Chapter 5, Page7, see 1st paragraph in section 5.05.

3. Drainage Boundaries and Hydrologic Modeling

An evaluation of the stormflow drainage above the Lucini property establishes that the County's delineation of subbasin boundaries is crucially inaccurate. As broken down numerically in Table 1 for ORIGINAL conditions, the south section area of the County's Subbasin 17S is erroneously depicted as draining to the Lucini property. The south section is labeled Subbasin 17Sa in Table 1 below.

The faulty subbasin delineations in the County's Drainage Report (2013) are illustrated in Figures 4 and 5. The ORIGINAL drawings in the County's report were digitized by LEA into the computer aided design software, AutoCAD. This allowed for the making of the scale model to evaluate the subbasins affecting the Lucini property. Conversion of subbasin area into HEC-HMS compatible units in square-miles (mi^2) was also performed. The County's errors in its stated original runoff areas, draining to the Lucini property, overestimate the original stormflows that the property can convey.

Table 1. Land Area Inputs for Subbasins above the Lucini Property
For ORIGINAL and IMPLEMENTED Subbasin Boundaries

		Original Drainage Areas			
	Washington County Subbasin ID	Scale Model AutoCAD in^2	HEC-HMS Input mi^2	Subbasin Size ft^2	Subbasin Size acres
Corrected South Section	17Sa	9117253	0.002267	63314	1.45
Corrected North Section	17Sb+c	27264059	0.006781	189334	4.35
Original County Total	17S	36381312	0.009048	252648	**5.8**
Corrected South Section	17Sa	9117253	0.002267	63314	1.45
Central-Section	17Sb	7464200	0.001856	51835	1.19
North-Section	17Sc	19799859	0.004924	137499	3.16
Original County Total (OK, check on total above)	17S	36381312	0.009048	252648	**5.8**
		Implemented Drainage Areas			
	Washington County Subbasin ID	Scale Model AutoCAD in^2	HEC-HMS Input mi^2	Subbasin Size ft^2	Subbasin Size acres
South-Section	59Sa	7999004	0.001989	55549	1.28
North-Section	59Sb	23991460	0.005967	166607	3.82
Implemented County Total	59S	31990464	0.007956	222156	**5.1**

This resulted in erroneously concluding that the Boones Ferry Road right-of-way to the south of the original culvert[13] flowed into the Lucini property. The actual Original subbasin excluded all of the rainfall runoff from the southern strip of the County's wrongly depicted subbasin. This condition is illustrated in Figure 5, which more accurately shows the ORIGINAL stormflow from the southern strip as being routed to the Greenhill Lane subbasin.[14]

Original and Implemented Stormflows
Table 2 compares realistic ORIGINAL stormflows, as determined in this analysis, to the County's erroneous stormflows based on faulty subbasin drainage boundaries. For Original peak storm flows, it is estimated that the increased drainage area depicted in the County's Drainage Report results in a storm flow increase of about 31.5 percent that is discharged to the Lucini property. The hydrologic model inputs and results for HEC-HMS realistic Original conditions are contained in Appendix H.

Table 2. ORIGINAL Peak Stormflows
County Values Compared to HEC-HMS

Percent Increases for Projected County versus Actual Drainage Area Conditions

	Washington County Flows Based on Boones Fy. Road Drainage Analysis (cfs)	**HEC-HMS Flows Based on Actua1 BFR Drainage Areas** (cfs)	**Increase of Storm Flows to Lucini Property** (Percent)
Original Washington County - Pre-construction (prior to 2013)	1.17	0.89	31.5% [15]
Original Wash. CO Land Area - Ongoing Land Use (LU)	*County did Not Consider*	1.71	92.1%
Original Wash. CO Land Area - Projected Full Build-out (BO)	*County did Not Consider*	2.85	220.2%

The County's Drainage Report did not consider on-going land use changes other than the existing farming and single dwelling 2-acre lots. When actual ongoing urbanization and more intense land use are considered, the increased stormflows to the Lucini property are projected to increase by about 92.1 percent.

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[13] This is the original 12-inch diameter concrete cylinder pipe (CCP) culvert, which is about 40-foot long, and identified as the County's Outfall #5.

[14] This is identified in the County's Drainage Report (2013) as Subbasin "17s". See the background image of Figure 4, which uses HexBox labels to identify subbasins.

[15] The calculation is: [(0.1.17 – 0.89) / 0.89] equals 0.315 or 31.5 percent.

Figure 6. Actual Original versus County Stated Peak Stormflow Conditions

Comparison based on Actual ORIGINAL Hydrologic Conditions - Prior to 2013

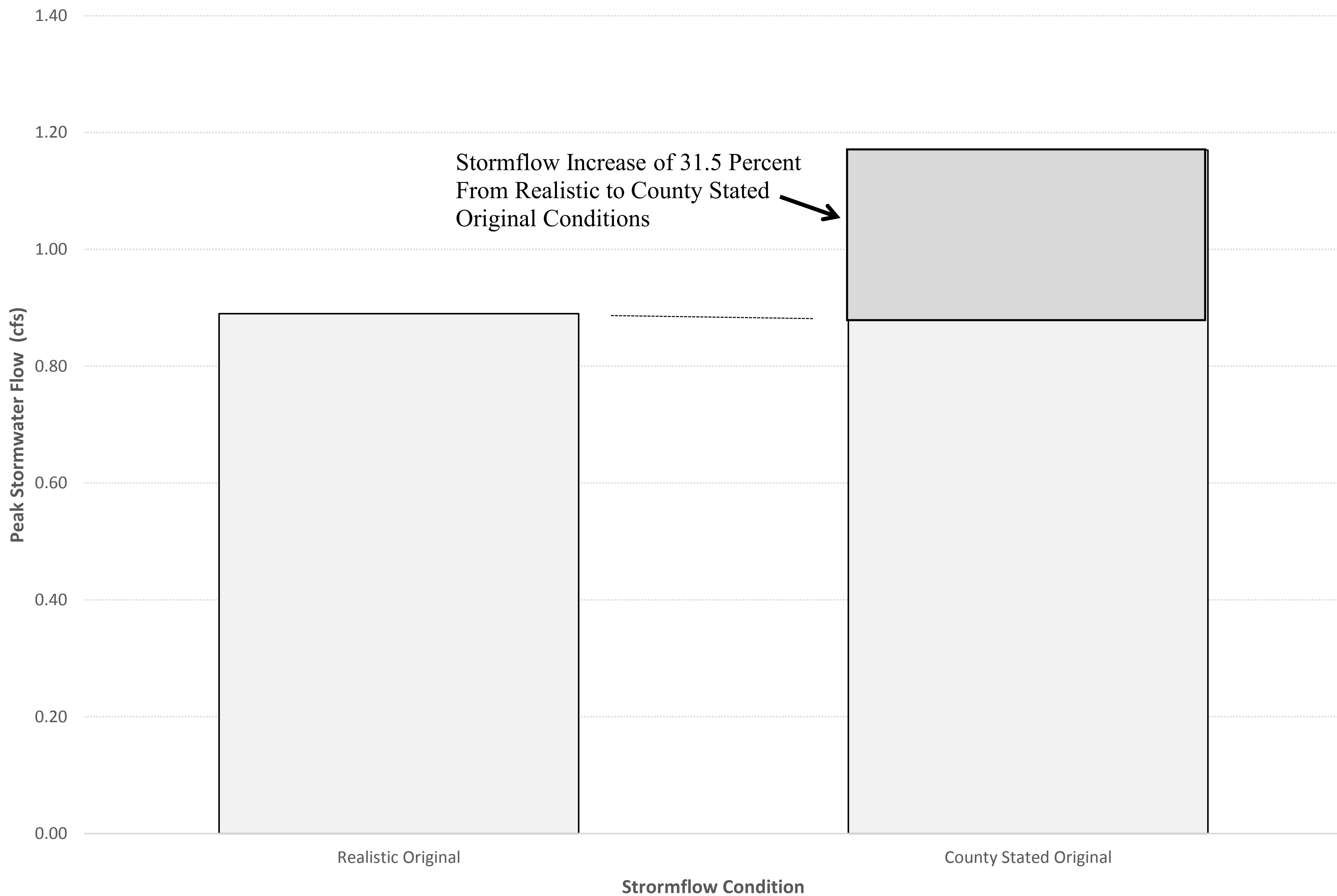
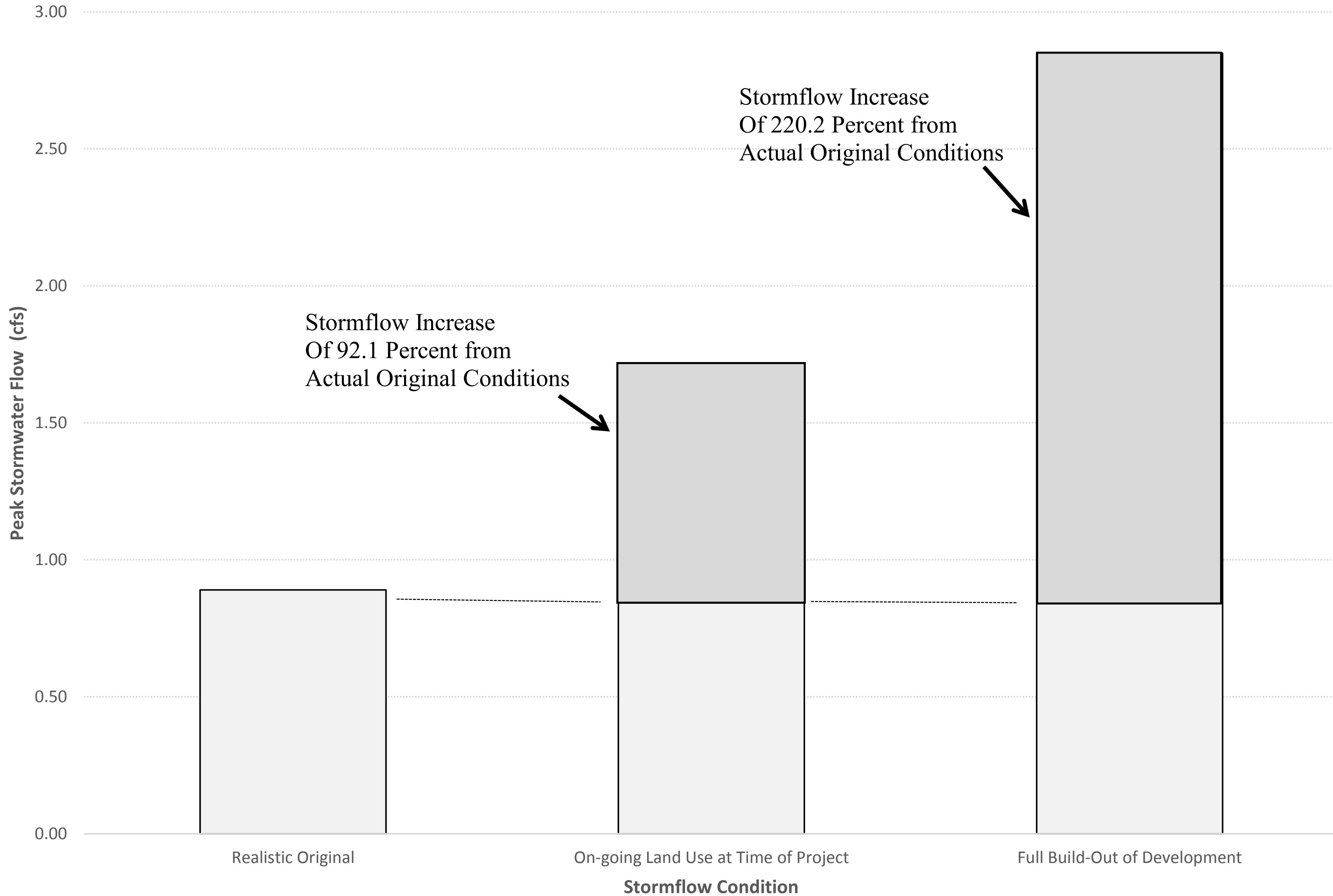


Figure 7. Increased Stormwater Peak Flows to the Lucini Property due to Ongoing Urban Land Use

Comparison based on Actual ORIGINAL Hydrologic Conditions - Prior to 2013



The County did not consider future full build-out construction conditions slated for the drainage above the Lucini property. When this necessary evaluation based on the CWS guidance is considered, the County will be increasing storm flows to the Lucini property by about 220.2 percent.

Table 3 compares IMPLEMENTED stormflows, as determined in this analysis, to the County's stormflows based on faulty subbasin drainage boundaries (see Figures 9 and 10). For the Implemented condition under previous land use, the LEA analysis and the County's analysis of peak flows are equal and no increase in flows is reported.

Table 3. IMPLEMENTED Peak Stormflows
County Values Compared to HEC-HMS

Percent Increases of Projected versus Actual Conditions

	Peak Storm Flow from HEC-HMS		
	Washington County Flows Based on Boones Fy. Road Drainage Analysis (cfs)	**HEC-HMS Flows Based on Actua1 BFR Drainage Areas** (cfs)	**Increase of Storm Flows to Lucini Property** (Percent)
Implemented Washington County - Post-construction (after about early 2015)	*County did not Consider* [16, 17]	0.64	32.8% [18]
Implemented Wash. CO Land Area - Ongoing Land Use (LU)	*County did Not Consider*	1.95	204.7%
Implemented Wash. CO Land Area - Projected Full Build-out (BO)	*County did Not Consider*	3.29	414.1%

The County's Drainage Report did not consider on-going land use changes. Only farming was evaluated. For Implemented peak storm flows, when on-going urbanization and more intense land use are considered, the increased storm flows to the Lucini property increase by about 204.7 percent.

The County did not consider future full build-out conditions construction scheduled for the drainage above the Lucini property. When this necessary evaluation based on the CWS guidance is considered, the County will be increasing storm flows to the Lucini property by about 414.1 percent.

[16] The County simulated Implemented conditions that resulted in a stormflow of 0.85 cfs. The LEA hydrologic model was adjusted to the County's implemented conditions and stormflow of 0.85 cfs.

[17] Stormflows less than Original conditions were not considered by the County. The County claimed in its Drainage Report (2013) that it was reducing Original stormflows by about 10 percent.

[18] The calculation is (0.85 – 0.64) / 0.64 equals 0.328 or 32.8 percent. Where 0.85 cfs is the lowest velocity considered by Washington County.

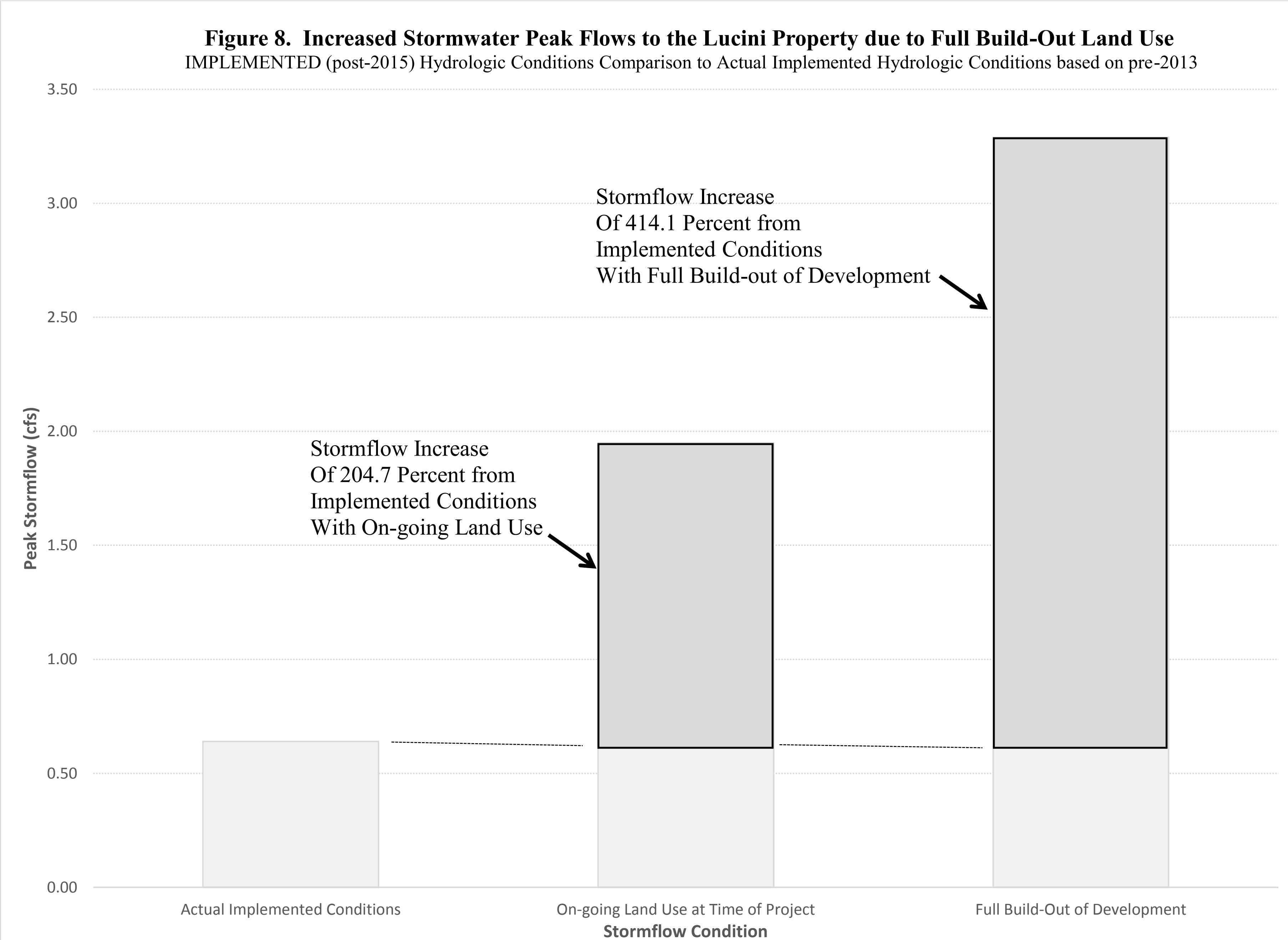
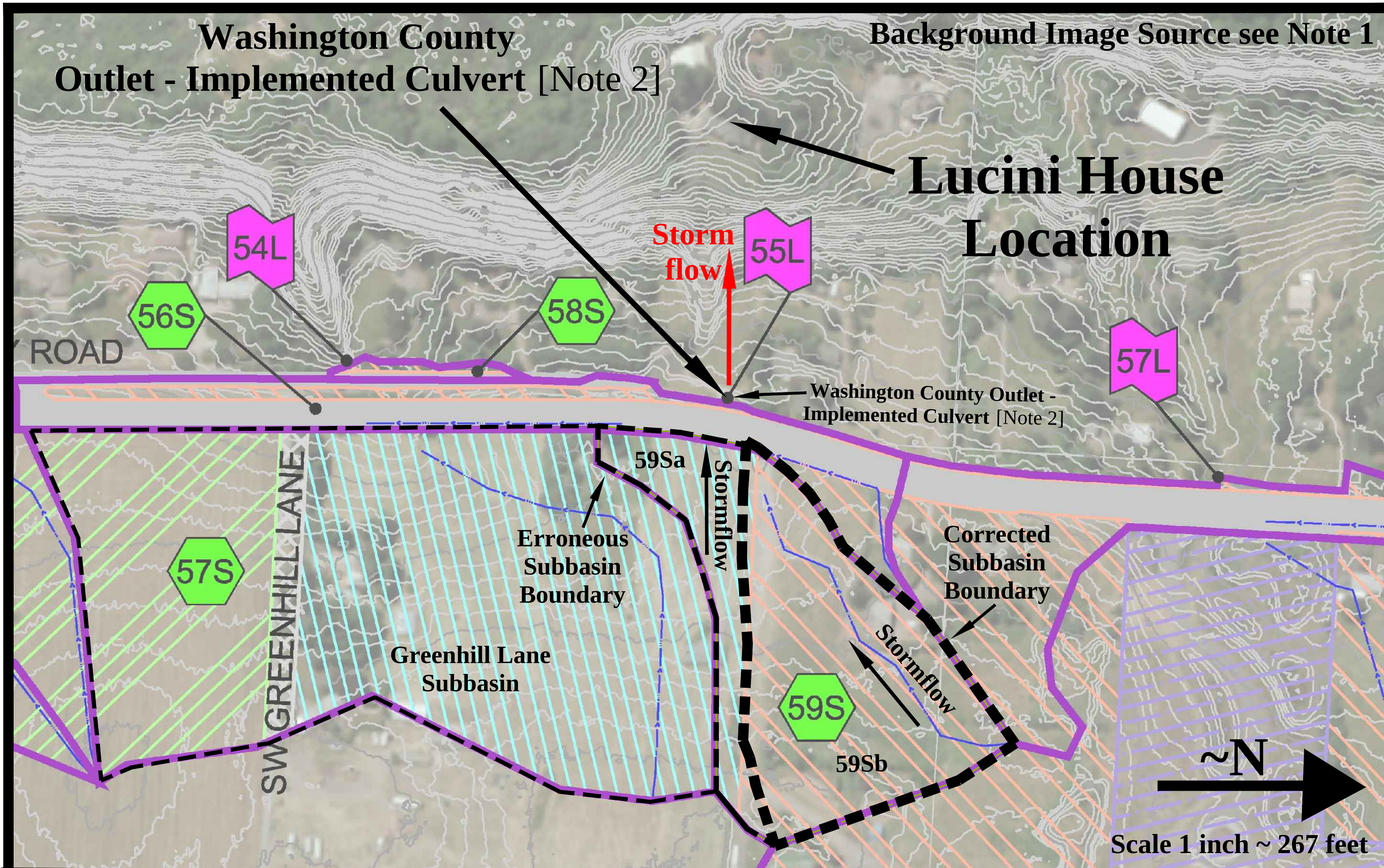


Figure 8. Increased Stormwater Peak Flows to the Lucini Property due to Full Build-Out Land Use
IMPLEMENTED (post-2015) Hydrologic Conditions Comparison to Actual Implemented Hydrologic Conditions based on pre-2013
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Peak Stormflow (cfs)
Stormflow Increase Of 414.1 Percent from Implemented Conditions With Full Build-out of Development
Stormflow Increase Of 204.7 Percent from Implemented Conditions With On-going Land Use
Actual Implemented Conditions
On-going Land Use at Time of Project
Full Build-Out of Development
Stormflow Condition

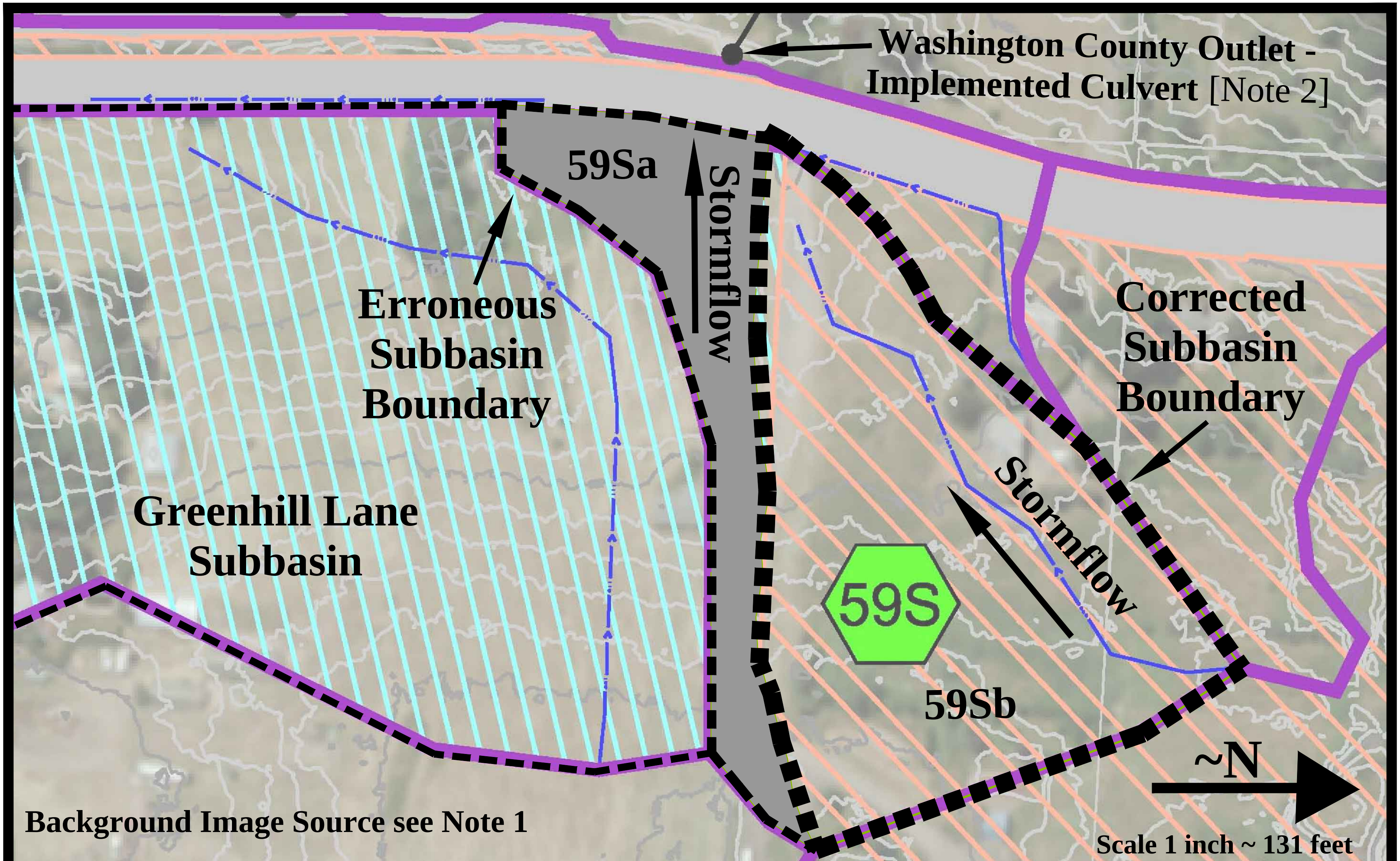


Notes:

[1] Background image source from Washington County *Storm Drainage Report* (January 2013), Existing Conditions Hydrology Map on PDF Page 36 of 152.

[2] Implemented Culvert, approximately 80-foot long, 12-inch Plastic (HDPE) discharging to the Lucini property. Overlayed from As-built construction plan drawings 232-233 of 385.

Figure 9. IMPLEMENTED County Subbasins - Erroneous Boundaries for Drainage above the Lucini Property.



Notes:

[1] Background image source from Washington County *Storm Drainage Report* (January 2013), Existing Conditions Hydrology Map on PDF Page 36 of 152.

[2] Implemented Culvert, approximately 80-foot long, 12-inch Plastic (HDPE) discharging to the Lucini property. Overlayed from As-built construction plan drawings 232-233 of 385.

Figure 10. IMPLEMENTED County Subbasins - Erroneous Boundaries for Drainage above the Lucini Property. (Close-in View)

Defective County Topography and Inaccurate Original Curb and Storm Sewer Claims
Stormflows originally directed south into the Greenhill Lane subbasin, through the road right-of-way, were re-routed by the road improvement project onto the Lucini property via the County's Storm Outfall #5. As shown in Figures 4 and 5, the subbasin drainage drawings for the ORIGINAL conditions[19] do not show the actual topography affecting drainage conditions. The IMPLEMENTED drainage basin conditions then re-route increased storm flows to the Lucini property.[20]

The County's Drainage Report says that the original road had curbs and storm sewers routing flows.[21] This is incorrect as there were no curbs or storm sewers for SW Boones Ferry Road above the Lucini property. Drawings 2C-7 and 2C-8 excerpted in Appendix C demonstrate there were no curbs and storm sewers upstream of the Lucini property.[22] Additionally, the photos in Appendix A1 taken by as part of the County's Wetland Delineation Report[23] and by the Lucini's also reveal the lack of curbs and storm sewers above the Lucini property. This is a crucial detail because it determines whether a portion of stormflows go south into the Greenhill Lane subbasin, or north into the subbasin above the Lucini property. In its Drainage Report the County erroneously claims that a portion of the Greenhill Lane subbasin stormwater drains into the Lucini property.

The photos contained in Appendix A1 show the ORIGINAL Drainage of Storm Water from SW Boones Ferry Road. Photo A1a was taken by Washington County September 28, 2012; and Photo A1b was taken by John & Grace Lucini on Dec. 20, 2012. Portions of the subbasins to the east (on the left) historically drained into the Road Alignment and then south away from the Lucini property. This is contrary to the analysis contained in the County's Drainage Report (2013), which wrongly states this road section is curbed including storm sewers, with portions of stormflows being directed into the Lucini property.

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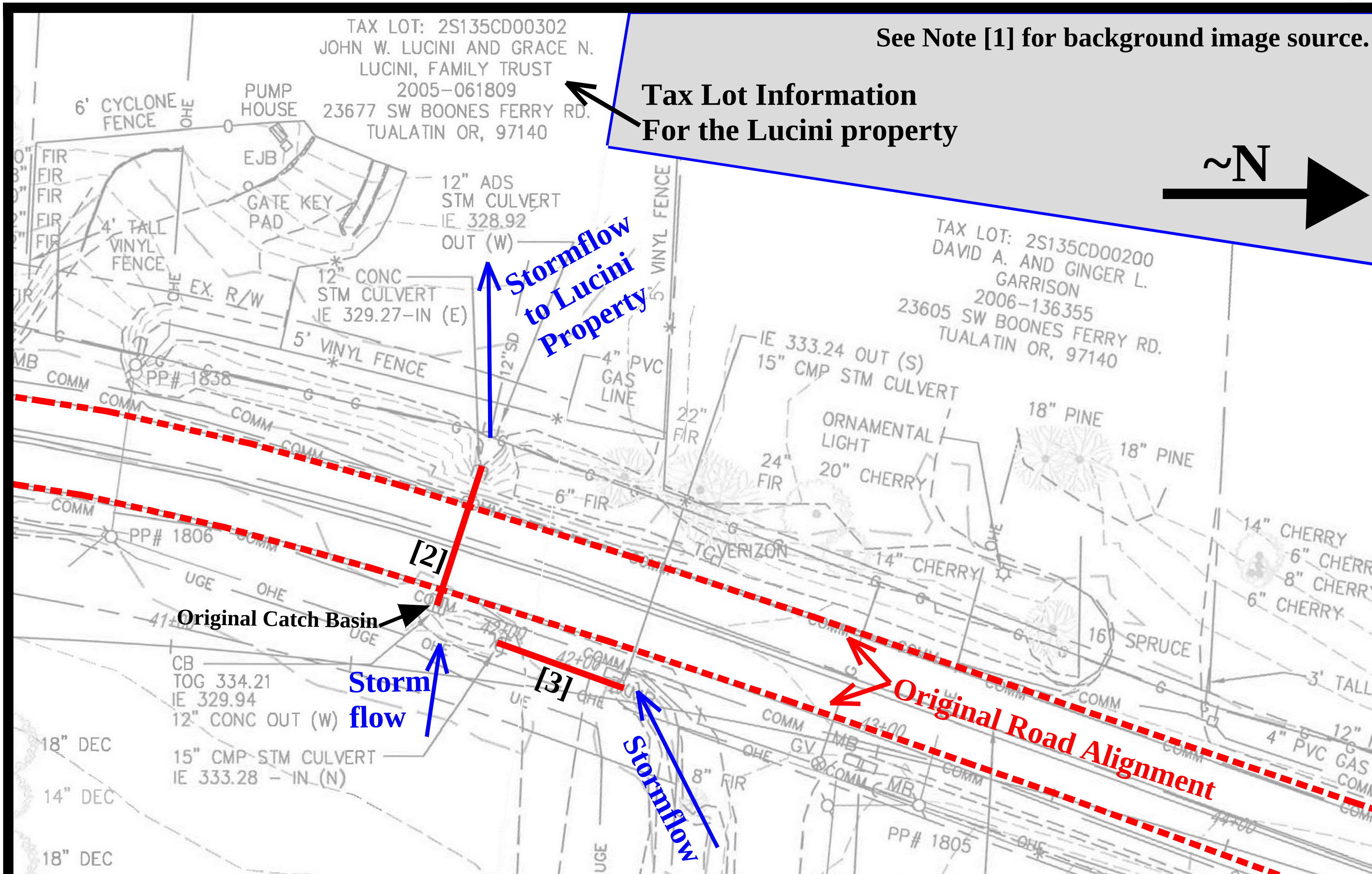
[19] Drainage Report (2013), Sheet No. 1 of 3 labeled "Existing Conditions Hydrology Map" on PDF page 35 of 152.

[20] Ibid, see Sheet No. 2 of 3 labeled "Proposed Conditions Hydrology Map" on PDF page 36 of 152.

[21] Drainage Report (2013), Storm Drainage Report – SW Boones Ferry Road (SW Day Road to SW Norwood Road, by MacKay Sposito for Washington County, Capital Project Management (CPM), Final January 31, 2013. See PDF page 59 of 152 under Summary of Subcatchment 17S, which is the drainage above the Lucini property. The Drainage Report erroneously states that the drainage is "w/curbs & sewers" which did not exist above the Lucini property. This faulty information and its implications were used in the County's hydrologic analysis.

[22] County 2012a, Drawings from MacKay Sposito submittal to the County contained in file: 2012 June Existing Conditions 70% Plans.pdf.

[23] County 2012b, See PDF page 81 of 90 in file: 2012 Dec Wetland Delineation Report-Boones Ferry Rd Improvement Project WD2013-0002.pdf.



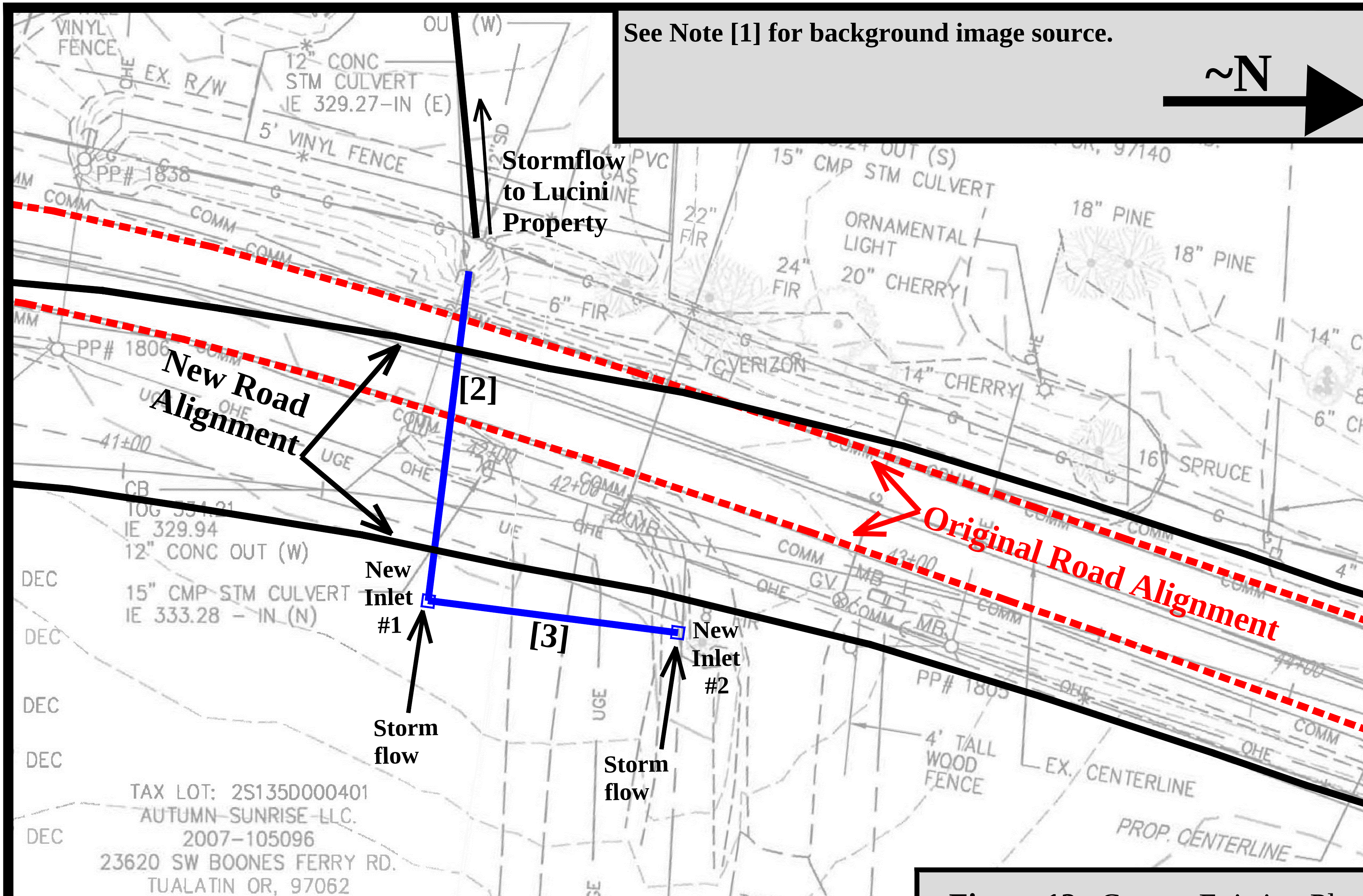
Notes:

[1] Background image from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

[3] Original Connecting Piping, about 42-foot long, 15-inch corregated metal pipe (CMP). Overlayed from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

Figure 11. County Existing Plan Drawings with Annotations Highlighting the ORIGINAL Conditions and Piping



Notes:
[1] Background image from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).
[2] New Culvert, 80-foot long, 12-inch Plastic (HDPE) discharging to the Lucini property. Culvert and piping overlay from As-built construction plan drawings 232-233 of 385.
[3] Connecting Piping, 74-foot long, 12-inch Plastic (HDPE) piping, under two driveways. Connecting Pipe overlay from As-built construction plan drawings 232-235 of 385.

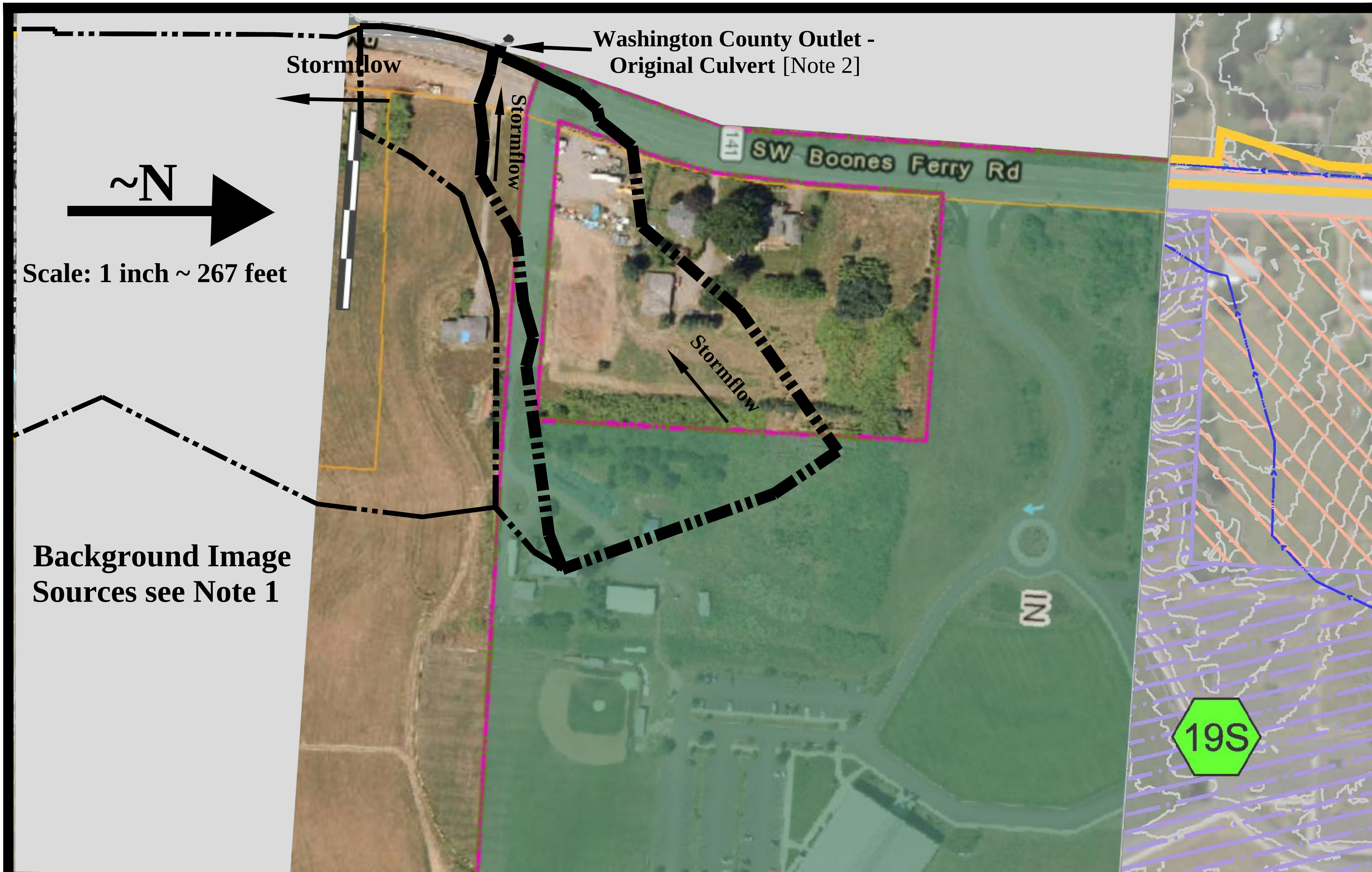
Figure 12. County Existing Plan Drawings with Annotations Highlighting the IMPLENTED Piping Conditions

Hydrologic Modeling and Construction Development

The County's Drainage Report disregarded construction development that increases run-off in the drainage upstream of the Lucini property. The County's hydrologic modeling of the upstream subbasin was characterized as "Farmstead" and single dwelling 2-acre lots. However, the actual additional use of a majority of the subbasin is to support heavy road construction and on-going use as commercial (Institutional), a more intense land-use from a stormwater generation standpoint. This relationship between the subbasin boundary delineation and active road construction (in 2012), equipment parking and material staging can be plainly seen in the aerial view presented in Figures 13 and 14.

The Natural Resources Conservation Service (NRCS) has commented on this problem of disturbed soil effectively raising runoff flows and has stated:

> **630.0702 Disturbed soils**
>
> As a result of **construction and other disturbances**, the soil profile can be altered from its natural state and the listed group assignments generally no longer apply, nor can any supposition based on the natural soil be made that will accurately describe the **hydrologic properties of the disturbed soil**. In these circumstances, an onsite investigation should be made to determine the hydrologic soil group. A general set of guidelines for estimating **saturated hydraulic conductivity** from field observable characteristics is presented in the Soil Survey Manual (Soil Survey Staff 1993).
>
> [Bold by LEA except subsection title.]

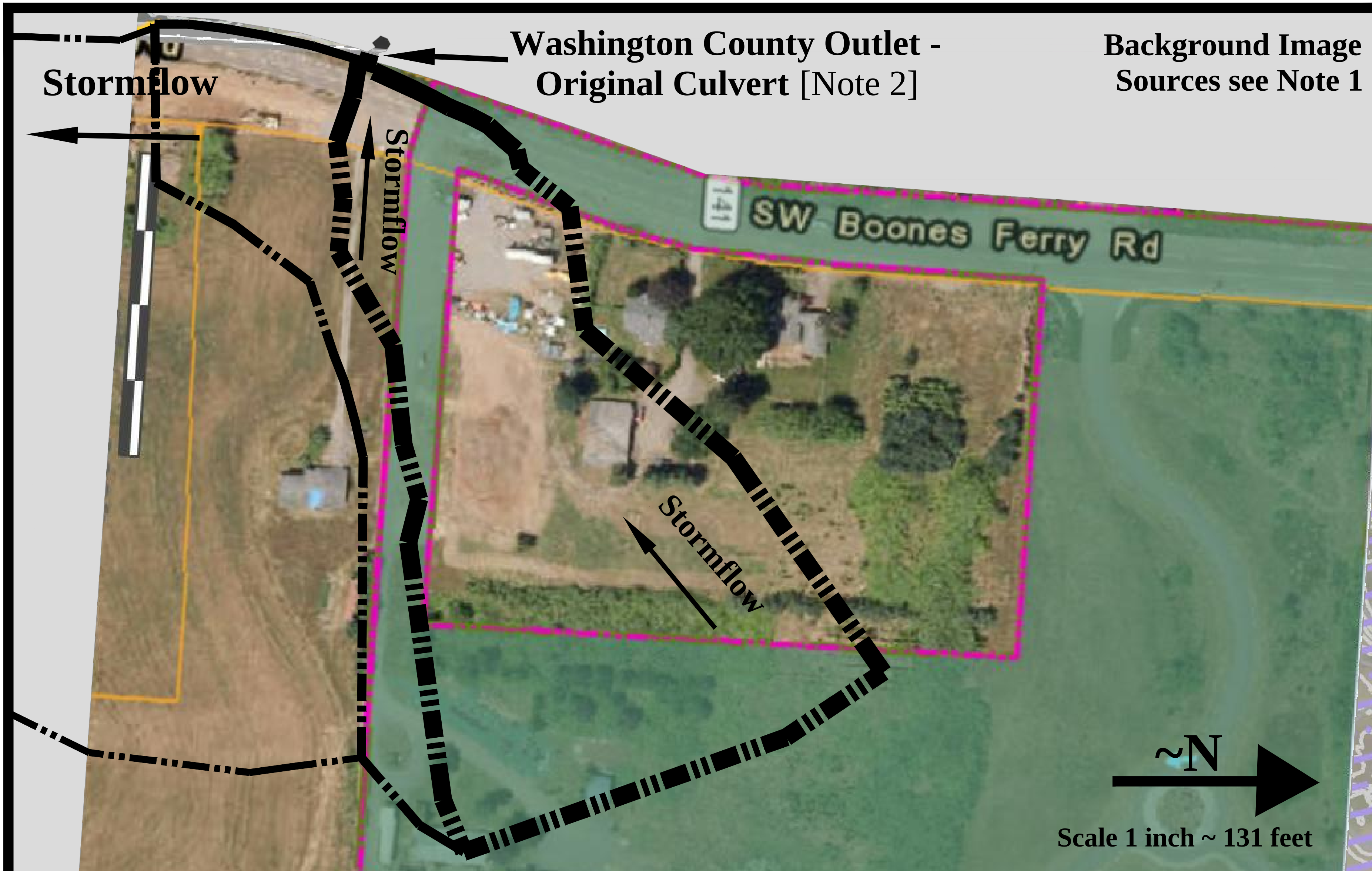


Notes:

[1] Background image sources are: 1) Aerial Map compiled by City of Tualatin, TualGIS and State of Oregon GEO; and 2) Washington County *Storm Drainage Report* (Jan 2013), Existing Conditions Hydrology Map on PDF Page 35 of 152.

[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

Figure 13. Aerial View Showing Impact of Road Construction and Ongoing Commercial (Institutional) Land Use.



Notes:

[1] Background image sources are: 1) Aerial Map compiled by City of Tualatin, TualGIS and State of Oregon GEO; and 2) Washington County *Storm Drainage Report* (Jan 2013), Existing Conditions Hydrology Map on PDF Page 35 of 152.

[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

Figure 14. Aerial View Showing Impact of Road Construction and Ongoing Commercial (Institutional) Land Use. (Close-in View)

4. Stormflow Hydraulics

The County's Drainage Report did not perform a hydraulic analysis to assess the effects of its stormflow above and through the Lucini property. The Corps hydraulic model, HEC-RAS[24], is used in this analysis to partly[25] fill-in this crucial lack of stormflow hydraulic information.

Rainfall runoff flows generated by the hydrologic model HEC-HMS are supplied as inputs to the HEC-RAS hydraulic model to consider the impact on drainage channels, piping, and other features of the drainage system. Specifically, the hydraulic effects resulting from stormflows passing through the drainage system subbasins, stormflow routing, channels, culverts (piping), land use conditions, channel and piping materials, and other parameters can be assessed.

Cross-sections and Other Hydraulic Information

The HEC-RAS hydraulic model requires the input of cross-sectional information that demarcate the channel with elevation versus distance from the bank. Additional information supplied to the model includes distance between cross-sections, hydraulic losses and other stormflow parameters.

The County has not provided the public with complete topography of the subbasin draining to the Lucini property, and other properties, below its Boones Ferry Road project site. Accordingly, channel and pipe cross-section information are estimated for input into the HEC-RAS hydraulic model. Summary input and output hydraulic information for the HEC-RAS simulation is contained in Appendix I.

The County did not consider the hydraulic effects of increased stormflow conditions on the Lucini property resulting from its Boones Ferry Road Improvement construction project. As discussed previously, increased stormflows onto the Lucini project are likely because of inaccurate subbasin delineation by the County. The County also failed to consider the effects of ongoing and future development, with increasingly intense land use and full-build-out conditions, contributing to increased stormflows.

Hydraulic Analysis Results

The County did not consider stormflow cases that take into account greater land use conditions and future development above the Lucini property. For example, the County disregarded the impact of its own road construction efforts, plainly visible in the aerial views in Figures 13 and 14 as well as Appendix F, on lands draining to the Lucini property. The County characterizes these activities as "farming" or single dwelling 2-acre lots.

[24] HEC-RAS refers to the River Analysis System hydraulic model developed by the Corps.

[25] This hydraulic analysis using HEC-RAS performs a steady-state evaluation for a range of peak stormflow conditions inputted from the HEC-HMS hydrologic model. A more detailed time-varying analysis employing unsteady stormflow conditions, with stormflow storage, may be warranted in future evaluation with additional planning information but is beyond the timing and scope of this report.

The analysis presented herein does take into account actual land use intensity and development circumstances as previously discussed in the Hydrologic Modeling section. This analysis evaluates conditions for both ORIGINAL and IMPLEMENTED hydraulic configurations for the range of runoff conditions presented in Tables 2 and 3, respectively. Appendix I contains the results of the hydraulic analysis.

Figure 15 depicts the hydraulic profile generated by HEC-RAS for the ORIGINAL configuration using runoff stormflows based on future full build-out development conditions at 2.85 cfs. Stormflow existing prior to the County's road project[26] (0.89 cfs) and additional profiles are also contained in Appendix I.

A key consideration in reviewing these figures is that the ground slope goes from moderate above (east) the Lucini property to very steep (west) on the Lucini property. The County's Drainage Report (2013) analysis did not consider this substantial change of slope and its likely effect, which is to cause high stormflow velocities and extremely erosive conditions, on the Lucini property.

Comparing velocities with likely stormflows demonstrates the value of reducing runoff flow peaks. High stormwater flows cause erosion and clog ditch and pipe locations. In this HEC-RAS analysis, 25-yr design storm events were varied by correcting for actual subbasin areas and using genuine land use conditions as described in the hydrologic Tables 2 and 3 of this report for the ORIGINAL and IMPLEMENTED configurations, respectively.

Figure 16 for the ORIGINAL configuration illustrates velocities for the upstream and downstream stations along the Lucini property approximate 150-foot ditch[27]. This figure shows that as stormflows increase from 0.89 cfs to 2.85 cfs, highly erosive storm velocities occur.

As charted in Figure 16, flow velocities in excess of 4.0 feet-per-second (fps) produce adverse conditions that erode soil.[28] This is consistent with the stormwater damage to the ditches, and pipe blockage, on the Lucini property (see photos in Appendix A2).

Figure 17 for the IMPLEMENTED configuration illustrates velocities for the upstream and downstream stations along the Lucini property approximate 150-foot ditch. This figure shows that as stormflows increase from 0.85 cfs to 3.29 cfs, highly erosive storm velocities will occur into the future.

The two lower flow conditions at 0.64 cfs and 0.85 cfs do not produce excessive storm velocities. The 0.64 cfs value is what the peak 25-year storm event should be if the County was actually reducing stormflows onto the Lucini property consistent with what it

[26] Prior to early 2013.

[27] This ditch is alongside the Lucini driveway and runs generally from east to west. See Figures 2 and 3 for the alignment of this drainage ditch relative to the County's road construction and the Lucini property.

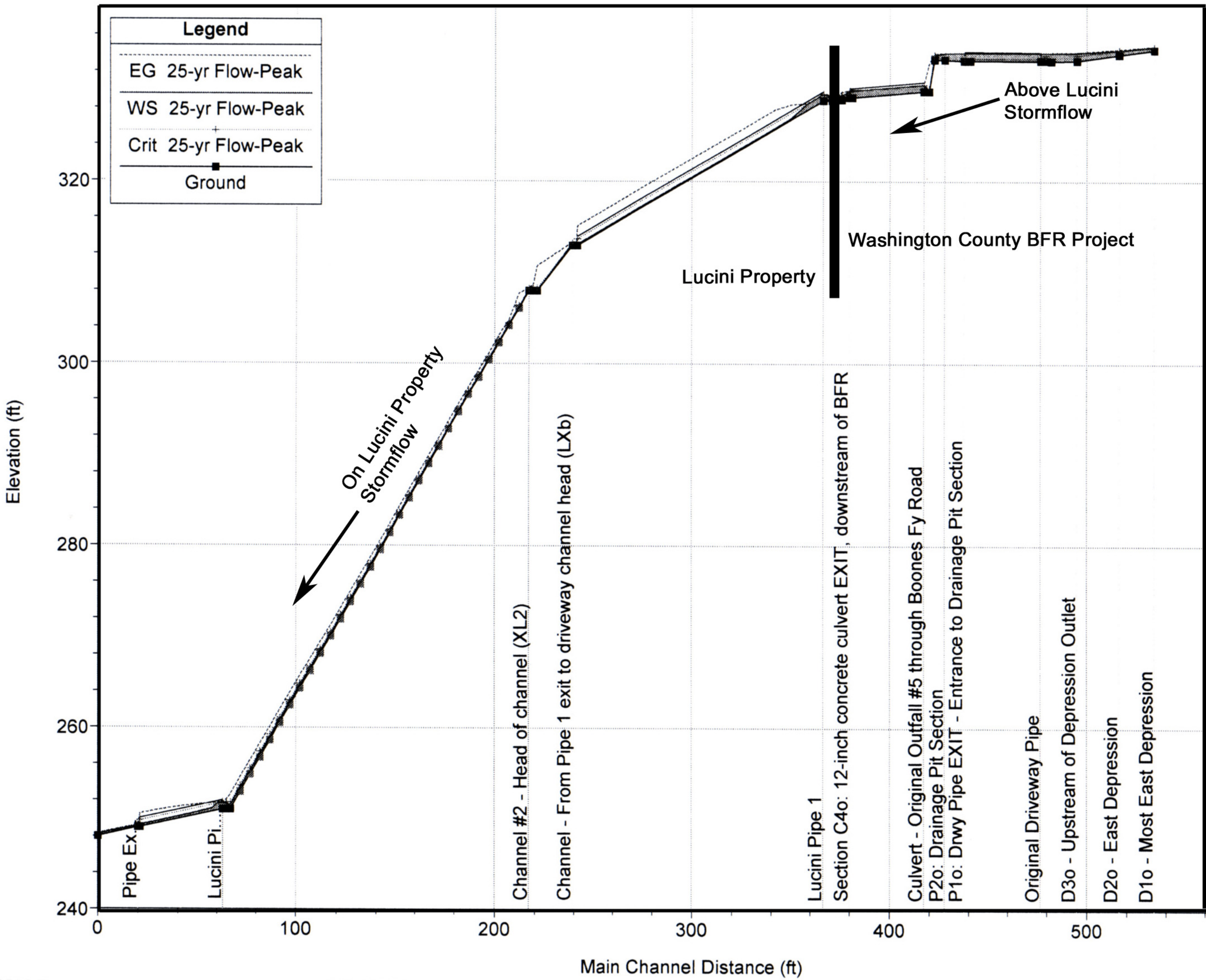
[28] Linsley, Ray K. and Franzini, Joseph B., Water-Resources Engineering, published by McGraw-Hill, 1979.

is saying in its Drainage Report. The 0.85 cfs value simulated by the County is for farmland only and does not include actual urbanization and increased runoff in the subbasin above the Lucini property. When actual ongoing land use is considered, stormflow of 1.95 cfs more accurately reflects actual runoff being discharged from the County's culvert (Outfall #5) onto the Lucini property.

An orifice plate can be used to reduce storm pipe flow diameter and flow area during peak flow events. This physical measure decreases peak stormflows and lowers storm flow velocities on the Lucini property. The location of the proposed orifice plate is shown in Figure 12 as indicated in the IMPLEMENTED new storm inlet #1.

The construction and installation plans for the orifice plate is shown in the guidance document relied upon by the County (CWS 2007). For convenience, the orifice plate drawings are presented in Appendix G (see CWA Drawings Nos. 720 and 730).

Figure 15. HEC_RAS Hydraulic Profile of ORIGINAL Pipe and Ditch Conditions at 2.85 cfs
Above and On the Lucini Property



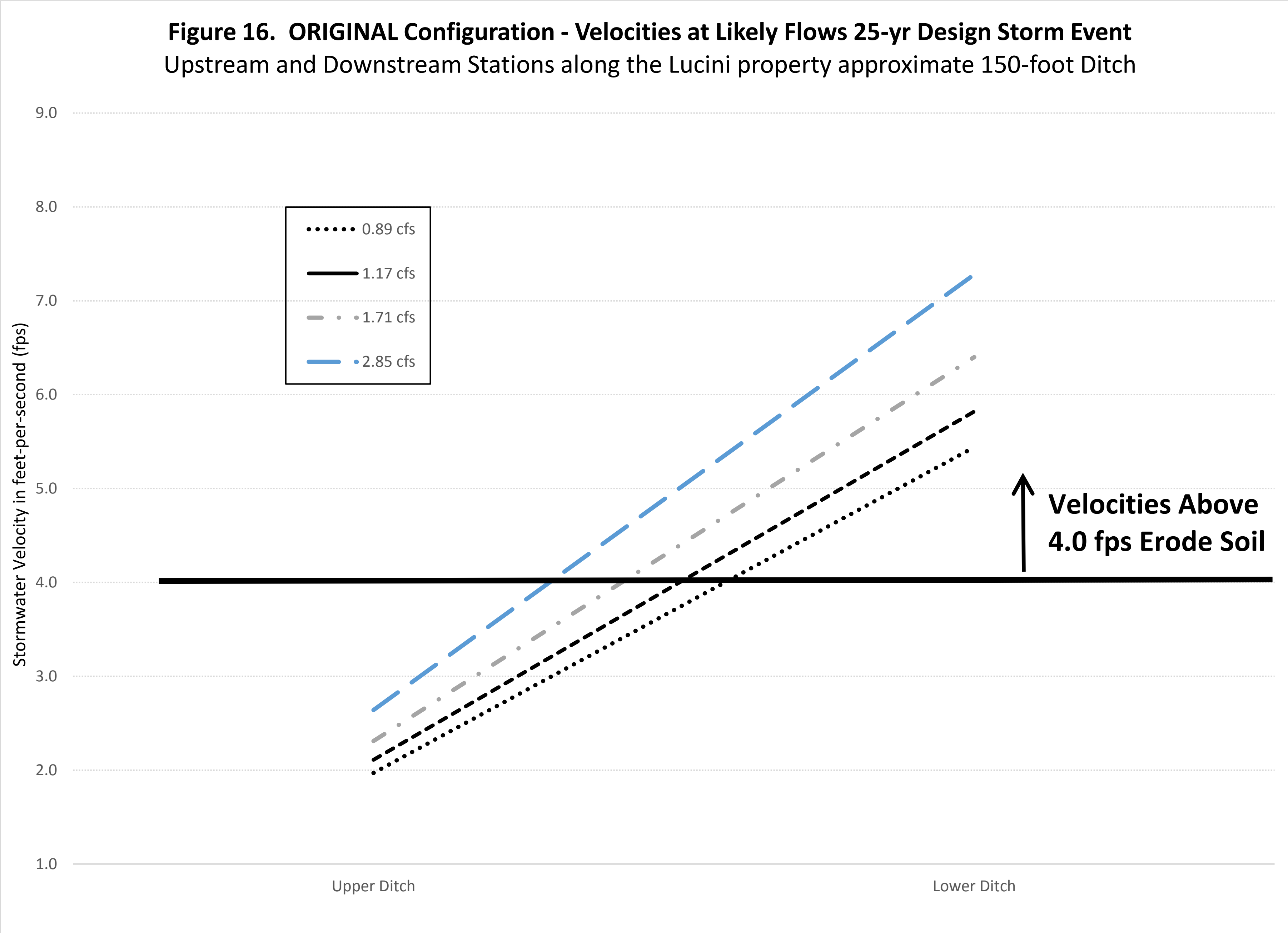


Figure 16. ORIGINAL Configuration - Velocities at Likely Flows 25-yr Design Storm Event
Upstream and Downstream Stations along the Lucini property approximate 150-foot Ditch
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
Stormwater Velocity in feet-per-second (fps)
0.89 cfs
1.17 cfs
1.71 cfs
2.85 cfs
Velocities Above
4.0 fps Erode Soil
Upper Ditch
Lower Ditch

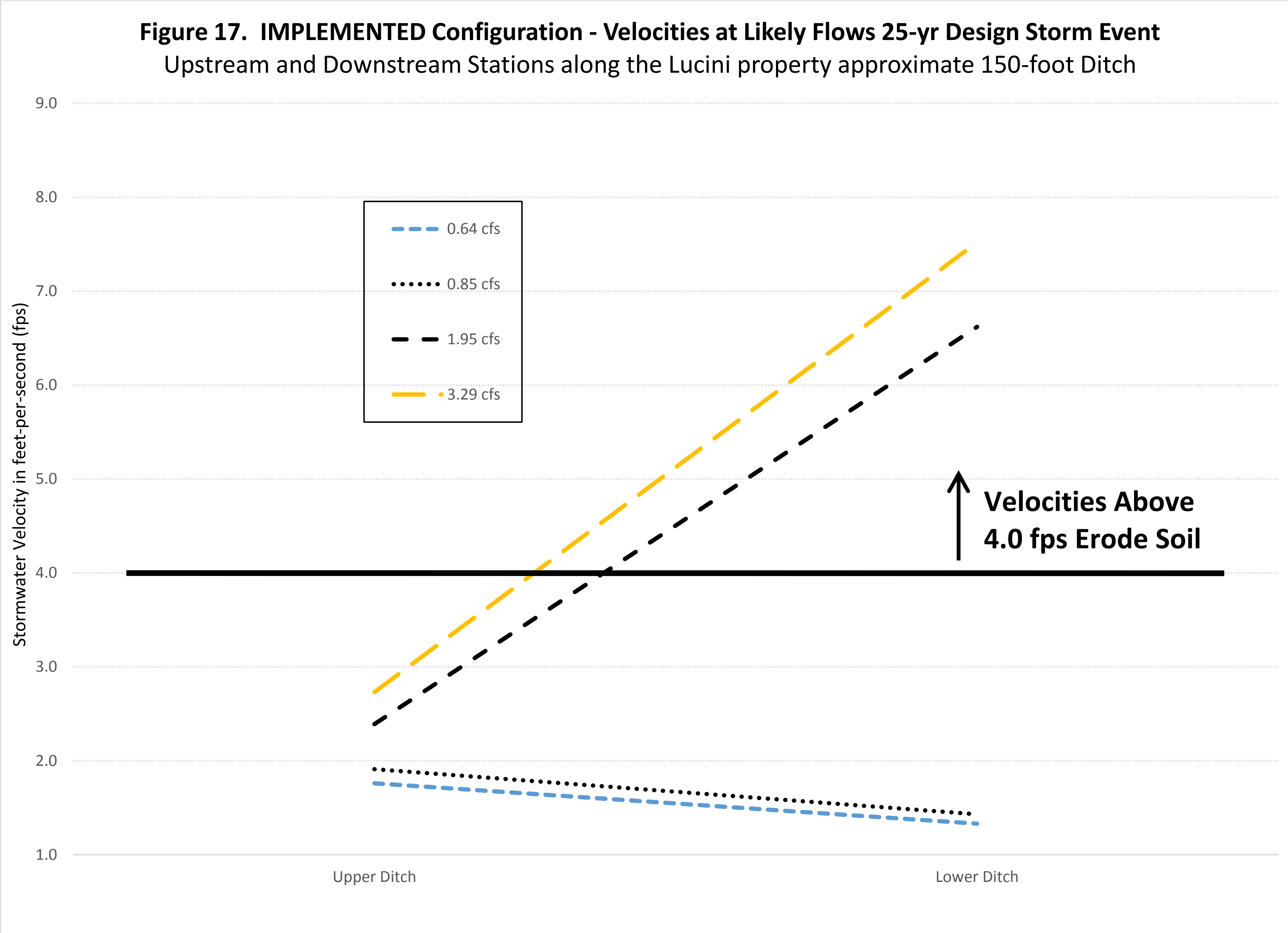


Figure 17. IMPLEMENTED Configuration - Velocities at Likely Flows 25-yr Design Storm Event
Upstream and Downstream Stations along the Lucini property approximate 150-foot Ditch
Stormwater Velocity in feet-per-second (fps)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.64 cfs
0.85 cfs
1.95 cfs
3.29 cfs
Velocities Above
4.0 fps Erode Soil
Upper Ditch
Lower Ditch

5. Planning Level Costs

There are three levels of estimated capital costs associated with fixing problems on the Lucini property resulting from the County's SW Boones Ferry Road project:

1) Immediate Shorter Term Remedy using Orifice Plate ($4,500 to $6,500 installed)
2) Ongoing Flow and Water Quality Control Facilities ($12,157 to $17,560 installed)
3) Longer Term Detention/Retention Facilities (to several hundred thousand dollars)

These capital costs include equipment, materials, labor, and construction contractor overhead and profit. Design, engineering and construction management costs are separately considered. An estimate of 20 percent of the final construction capital cost for this relatively small scale project is considered. For the high range estimates above, the design cost estimates are $1,300 for number 1 and $3,572 for number 2.

These are planning level capital costs and are presented in a range between the lower cost that is 10 percent below the estimated base cost; and the high cost that is 30 percent above the estimated base cost. Presenting only a single estimated base cost is not adequate for planning purposes and providing costs as a range is more convenient. Planning level costs for construction are presented using this cost range method because direct bid costs are not part of this study. While actual bid costs may come in lower (e.g., 10 percent), if actual potential bid costs are higher (e.g., up to 30 percent) then the outcome is undesirable if unaccounted for.

1) Immediate Shorter Term Remedy

This remedy alleviates the immediate problem on a short-term basis by reducing peak stormflows and consequent erosion on the Lucini property. This can be accomplished by using an orifice plate at the County's New Inlet #1 (this is the south inlet). The proposed orifice location is shown in Figure 12 at the New Inlet #1. The orifice would be installed at the upstream end of the implemented 80-foot long, 12-inch diameter culvert comprising the County's Outfall #5.

The County has indicated it is using CWS 2007 for guidance, which contains the Drawing No. 730 "Orifice Plate and Guide" that can be installed in New Inlet #1. For convenience, the CWS Drawing No. 730 is contained in Appendix G of this report. Orifice plate openings of 6, 8 and 10 inches can be fabricated and each used separately until it is determined which size best reduces peak flows and most efficiently uses storage in the IMPLEMENTED pipes, ditches and depressions.

The installed orifice fits into the new inlet without structural changes to the inlet. Construction materials are not extensive or expensive. Accordingly, the cost of installation of this immediate remedy is estimated in the range of $4,500 to $6,500.

2) Ongoing Flow and Water Quality Control Facilities

Estimated costs of the intermediate remedy facilities are listed in Table 4.[29] Both flow and water quality (WQ) control are needed because high stormflow velocities cause erosion upstream as well as on the Lucini property. Debris and sediment transport are a significant threat to the Lucini property because it clogs downstream piping and causes flooding. The County did not evaluate stormwater conveyance from its road project through the Lucini property. Increased amounts of runoff directed to the Lucini property, and its effects, were disregarded in the County's drainage assessment.

Table 4. Capital Costs of Ongoing Flow and Water Quality Control Facilities

Control Unit	**Base Cost**
Flow Control Manhole Installed to the East of BFR at the south New Inlet #1 location.	$8,046
Water Quality Manhole Installed to the West of BFR just above the Lucini property.	$5,462
Total Estimated Base Costs	**$13,800**
Estimation Range Between (-10% and +30%)	**$12,157** to **$17,560**

The County provided storm grates on its two new stormwater inlets in the subbasin above the Lucini property as shown in Figure 12. The County neglected to provide a storm grate for the pipe entrance to the Lucini property (see Figure 12). The Lucini property drainage receives stormwater passing through SW Boones Ferry Road culvert (Outfall #5). The County supposed that its generated stormflow will be conveyed successfully through the Lucini property. The Corps HEC-HMS and HEC-RAS demonstrate that this is not the case for the 25-year design storm cases presented in this analysis.

It is important to note that the Greenhill Lane subbasin, to the south of the Lucini property, has received flow and water quality control. The Greenhill Lane subbasin and the Lucini property both drain to the Basalt Creek wetlands. For the Greenhill Lane subbasin, which has dual outfalls the County used at least three (3) manholes to control

[29] Costs are based on *RS Means Building Construction Cost Data* (2010). Costs are adjusted for inflation based on the cost index as published by the Engineering News Review (ENR). In this case the index is set at 8800.66 for 2010 and 10337.05 for 2016. This is calculated as an inflation ratio of 1.175, i.e., an inflation rate of 17.5 percent from 2010 to 2016.

flow and a water quality manhole to control pollution. The subbasin draining to the Lucini property has no manholes to control flow nor a water quality manhole to control pollution including eroded sediment and debris.

While the Greenhill Lane subbasin typically will have greater stormflows, the necessity of controlling excess stormflows to the Lucini property is no less significant. This is especially true because the County performed no downstream system evaluation for hydraulic conditions on the Lucini property and has no basis for discharging excess flows to the Lucini property.

The County has indicated it is using CWS 2007 for guidance, which contains: Drawing No. 270 "Flow Control Structure Detail" that can be installed at the New Inlet #1 location; and Drawing No. 240 "Water Quality Manhole (Mechanical)" that can be installed just upstream of the Lucini property pipe entrance. For convenience, CWS Drawing Nos. 270 and 240 are contained in Appendix G of this report. See Figure 12 for the locations of these proposed flow and water quality control facilities.

3) Longer Term Detention/Retention Facility
Future full build-out development in the subbasin draining to the Lucini property was not considered by the County's Drainage Report (2013). This is surprising because the subbasin is zoned for future development (FD-20)[30] and includes Tualatin's Institutional (IN) development as characterized by the Horizon Community Church with its large buildings, extensive driveways, parking lots, and numerous support facilities. Ongoing development in the subbasin above the Lucini's, including the construction of the BFR widening project itself, demonstrate that the trend of more intense urban development is already underway and having an effect on the Lucini property.

As shown in the hydrologic and hydraulic evaluations in this report, ongoing urban development is already producing stormflows that exceed ORIGINAL conditions, by about 220 percent, that the Lucini property has historically been subjected to (see Figure 7). Urban development above the Lucini property, under full build-out conditions, pose a still greater threat. These stormflow projections exceed, by about 414 percent, the ORIGINAL stormflow conditions that the Lucini property has historically been subject to as depicted in Figure 8.

Stormflows with ongoing development and full build-out conditions draining to the Lucini property require substantial detention (flow control) and retention (WQ control) measures. These stormwater control units are absent from the Drainage Report (2013) and have not been considered by the County.

The design and detailed costing of detention/retention facilities is beyond the scope of this report but construction and land costs could be as high as several hundred thousand dollars.

[30] Washington County 20-year Future Development (FD-20), see PDF Page 33 of 152

Supplement B: Part 2 – Rpt Appendices

Included under separate cover because of size.

Appendices - *Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property* (LEA, November 2016)

Appendices

Appendix A

Appendix A1

Photos of ORIGINAL SW Boones Ferry Road
Above and just south of the Lucini Property

Photos taken prior to BFR Road Widening Project of 2013. The County's photo was taken on September 28, 2012 and the Lucini's photo was taken on December 20, 2012.

Photo A1a. This photo is from the County's Wetland Delineation Report (December 2010, PDF Page 81 of 90), which indicates the view is: "Looking south at the north - central portion of the study area." The County identifies this photo as "Photo K" taken on September 28, 2012. The mailbox on the right (to the west) identifies the Lucini property at 23677 SW Boones Ferry Road. The approach sign indicates the Greenhill Lane entrance is ahead but it is not visible because of the vertical curve in the road. There are no curbs or storm sewers in this section of the Boones Ferry Road contrary to the County's Drainage Report (2013).

Photo A1b. Drainage from the ORIGINAL Boones Ferry Road (December 2012). Looking northerly with ponding on the eastern (right) portion of the road. The white fence line of the Lucini property can be seen in the distance in the upper left of the photo, i.e., looking to the northwest. There are no curbs or storm sewers in this section of the ORIGINAL Boones Ferry Road contrary to the claim made in the County's Drainage Report (January 2013).

Appendix A2

Photos taken by John and Grace Lucini on May 18, 2015.
Showing the Downstream System conveying stormflows from
the SW Boones Ferry Road widening project

Excessive storm flows on May 18, 2015 overwhelmed the Lucini property.

Photo A2a. Storm flood waters directed to the Lucini property from Boones Ferry Road (5-18-15).

Photo A2b. Channel conveying Boones Ferry Road drainage across the Lucini property (5-18-15).

Photo A2c. The junction for the ditch and driveway pipe are overwhelmed and flood waters drain into the front yard toward the house (5-18-15).

Photo A2d. Flooding storm water ultimately found its way onto the porch and steps of the house and into the lower driveway area (5-18-15).

Photo A2e. The front lawn drained its flood waters into the walkway and porch in front of the house.

Photo A2f. The front walkway steps drain into the lower driveway and garage area.

Photo A2g.
Flooding stormwater ultimately found its way into the lower driveway and garage area.

Appendix A3

Photos of Ongoing Erosion on Lucini Property (taken August 19, 2016)

Photo A3a. This photo of the Lucini property ditch was taken on August 19, 2016 and looks generally northeast up the slope to the pipe end exiting from the County's road project. This photo shows the continuing effects of erosion with the ditch spreading east and west into the embankment where bare soil and tree roots are exposed. To slow flows the owner has placed riprap and concrete block in the ditch to reduce stormwater flow velocities that continue to erode the channel requiring ongoing repairs. This photo corresponds to the flood location in photo A2a of the previous Appendix A2, which shows high velocity storm flows into the Lucini property.

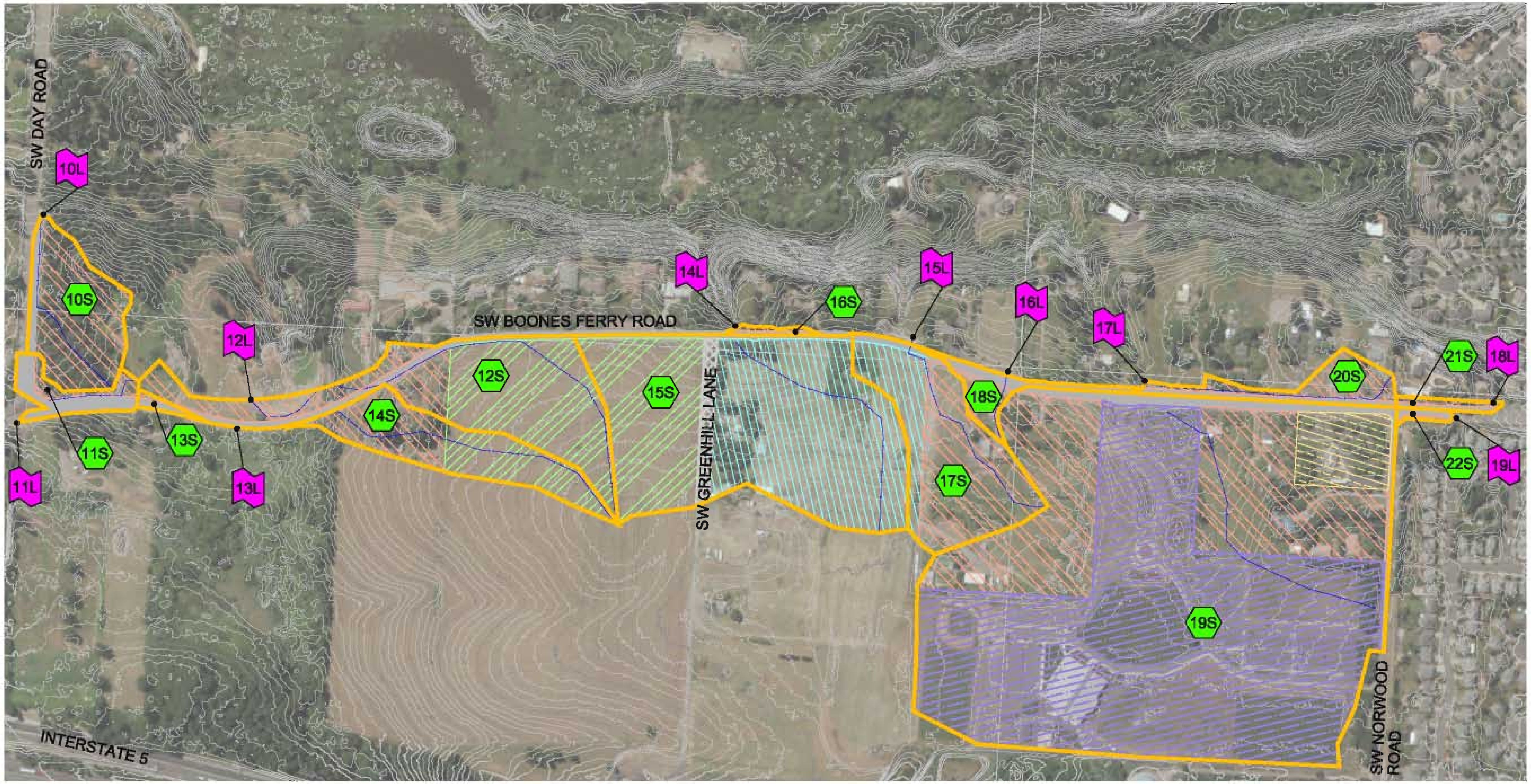
Photo A3b. This photo of the Lucini property ditch was taken on August 19, 2016 and looks generally east up the slope of the driveway. This photo shows the continuing effects of erosion with the ditch spreading south toward the driveway, and north into the embankment where bare soil and tree roots are exposed. To slow flows and reduce erosion, the owner has placed riprap in the ditch and gravel next to the driveway. However, very high stormwater velocities continue to erode the channel requiring ongoing repairs.

Photo A3c. This photo of the Lucini property ditch was taken on August 19, 2016 and looks generally northeast up the slope. This photo shows the continuing effects of erosion with the ditch spreading north into the embankment where bare soil and tree roots are exposed. To slow flows the owner has placed riprap in the ditch to reduce stormwater flow velocities that continue to erode the channel requiring ongoing repairs. This photo corresponds to the flood location in Photo A2c of the previous Appendix A2. The entrance to the 12-inch driveway culvert, which carries stormflows to the right (to the south), is hidden from view by the large rock at the bottom of the photo. See the next photo (A3d) for a view of the entrance to the driveway culvert).

Photo A3d. This photo of the westernmost base of the ditch was taken on August 19, 2016 and looks generally west toward the Lucini house. Shown the basin where stormwater collects and is routed into the entrance of the 12-inch corrugated plastic pipe (CPP), which is visible in the center of the photo. This pipe entrance allows flows to go south into the driveway culvert. Although a reversed view, this photo corresponds to the flood location in Photo A2c of the previous Appendix A2.

Appendix B

EXISTING CONDITIONS HYDROLOGY MAP



LEGEND

- *EXISTING CONDITION SUBBASIN BOUNDARY*
- *TIME OF CONCENTRATION FLOW LINE*
- 1S *SUBBASIN NODE*
- 1L *DISCHARGE LOCATION NODE*
- *LIDAR CONTOURS, 2' AND 10' (CITY OF WILSONVILLE)*

LAND USE (HYDROLOGIC MODEL)

- *PAVEMENT*
- *2-ACRE LOTS*
- *CHURCH*
- *CROPS*
- *FARMSTEAD*
- *GRAVEL*
- *SCHOOL*

N

0 400 800

SCALE: 1" = 400'

EXISTING CONDITIONS HYDROLOGY

DISCHARGE LOCATION	PRIMARY SITE CONVEYANCE	DOWNSTREAM RECEIVING ENTITY	CONTRIBUTING SUBBASINS
10L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF WILSONVILLE)	10S
11L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF WILSONVILLE)	11S
12L	MISC SURFACE FLOW	EXISTING DRAW, WEST	12S
13L	MISC SURFACE FLOW	EXISTING DRAW, SOUTHEAST	13S,14S
14L	CULVERT(S)	EXISTING RAVINE, WEST	15S, 16S
15L	CULVERT(S)	EXISTING PIPE CONVEYANCE, WEST	17S
16L	PAVEMENT RUNOFF	NON-POINT SHEET FLOW	18S
17L	CULVERT(S)	EXISTING CHANNEL, SOUTHWEST	19S, 20S
18L	MISC SURFACE FLOW	EXISTING ROADSIDE LOWPOINT, WEST	21S
19L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF TUALATIN)	22S

SW BOONES FERRY RD.
SW DAY ST. TO SW NORWOOD RD.
WASHINGTON COUNTY

HYDROLOGY MAPS

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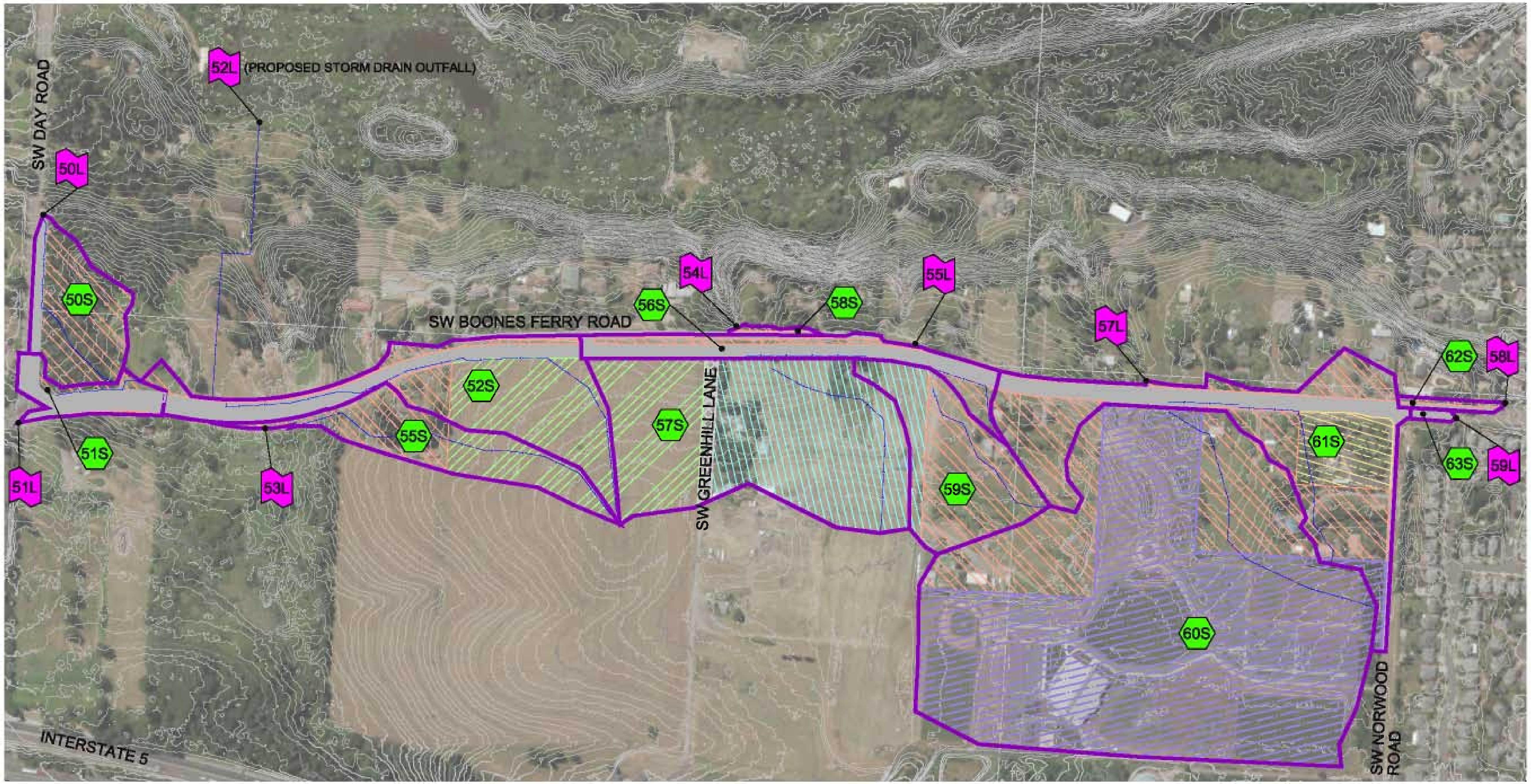
PROJECT NUMBER
100096

SHEET NO.
1 OF 3

SHEET TITLE
HYD1

PROPOSED CONDITIONS HYDROLOGY MAP



LEGEND

PROPOSED CONDITION SUBBASIN BOUNDARY

TIME OF CONCENTRATION FLOW LINE

1S SUBBASIN NODE

1L DISCHARGE LOCATION NODE

LIDAR CONTOURS, 2' AND 10' (CITY OF WILSONVILLE)

LAND USE (HYDROLOGIC MODEL)

PAVEMENT

2-ACRE LOTS

CHURCH

CROPS

FARMSTEAD

GRAVEL

SCHOOL

PROPOSED CONDITIONS HYDROLOGY

DISCHARGE LOCATION	PRIMARY SITE CONVEYANCE	DOWNSTREAM CONVEYANCE DESCRIPTION	CONTRIBUTING SUBBASINS
50L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF WILSONVILLE)	50S
51L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF WILSONVILLE)	51S
52L	PROPOSED STORM DRAIN	BASALT CREEK MARSH	52S
53L	MISC SURFACE FLOW	EXISTING DRAW, SOUTHEAST	55S
54L	PROPOSED STORM DRAIN	EXISTING RAVINE, WEST	56S, 57S, 58S
55L	CULVERT(S)	EXISTING PIPE CONVEYANCE, WEST	59S
56L	NOT USED	NON-POINT SHEET FLOW	NOT USED
57L	PROPOSED STORM DRAIN	EXISTING CHANNEL, SOUTHWEST	60S, 61S
58L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF TUALATIN)	62S
59L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF TUALATIN)	63S

N

0 400 800

SCALE: 1" = 400'

SW BOONES FERRY RD.
SW DAY ST. TO SW NORWOOD RD.
WASHINGTON COUNTY

HYDROLOGY MAPS

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PROJECT NUMBER
100096

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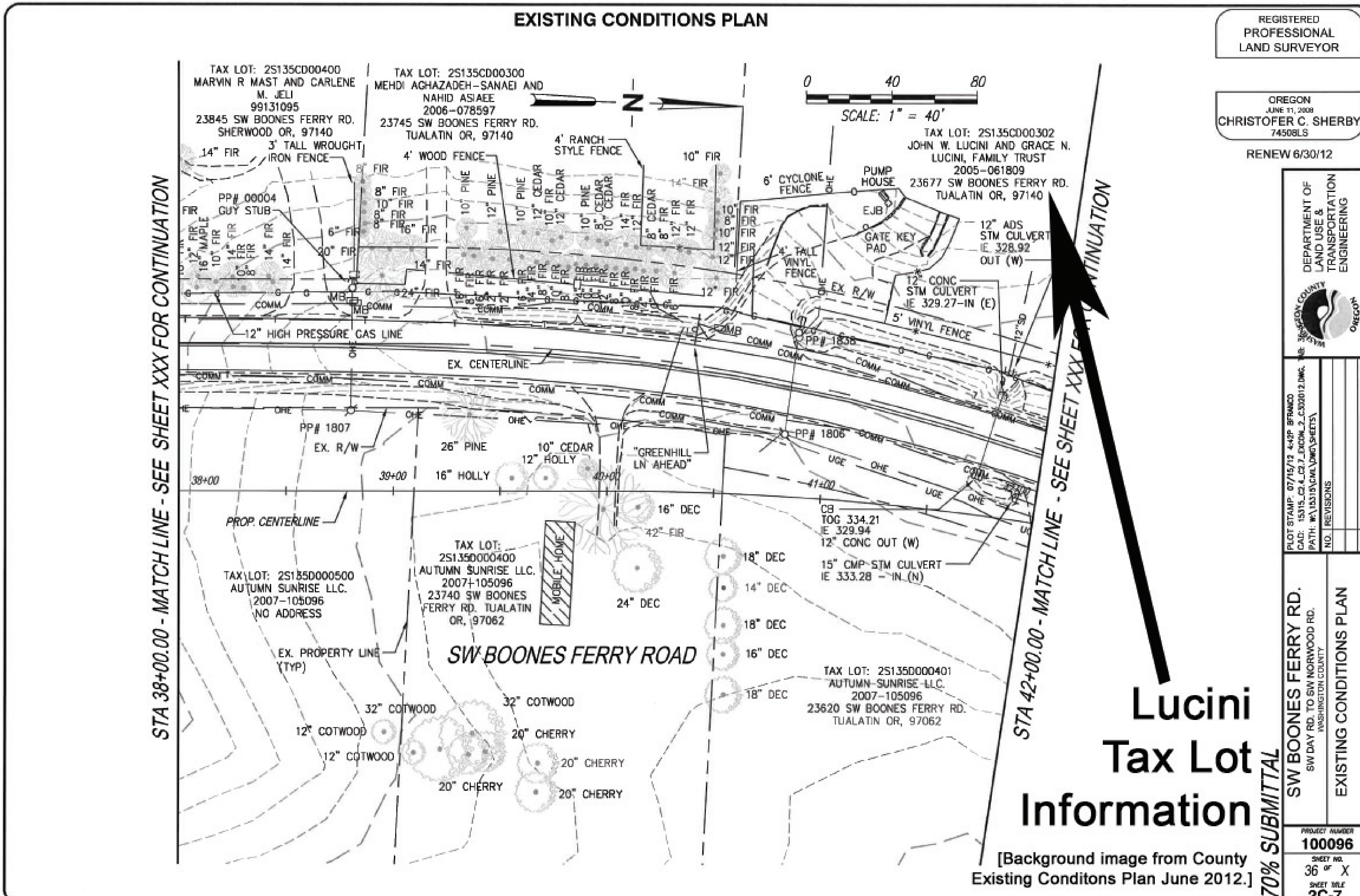
2 OF 3

SHEET TITLE
HYD2

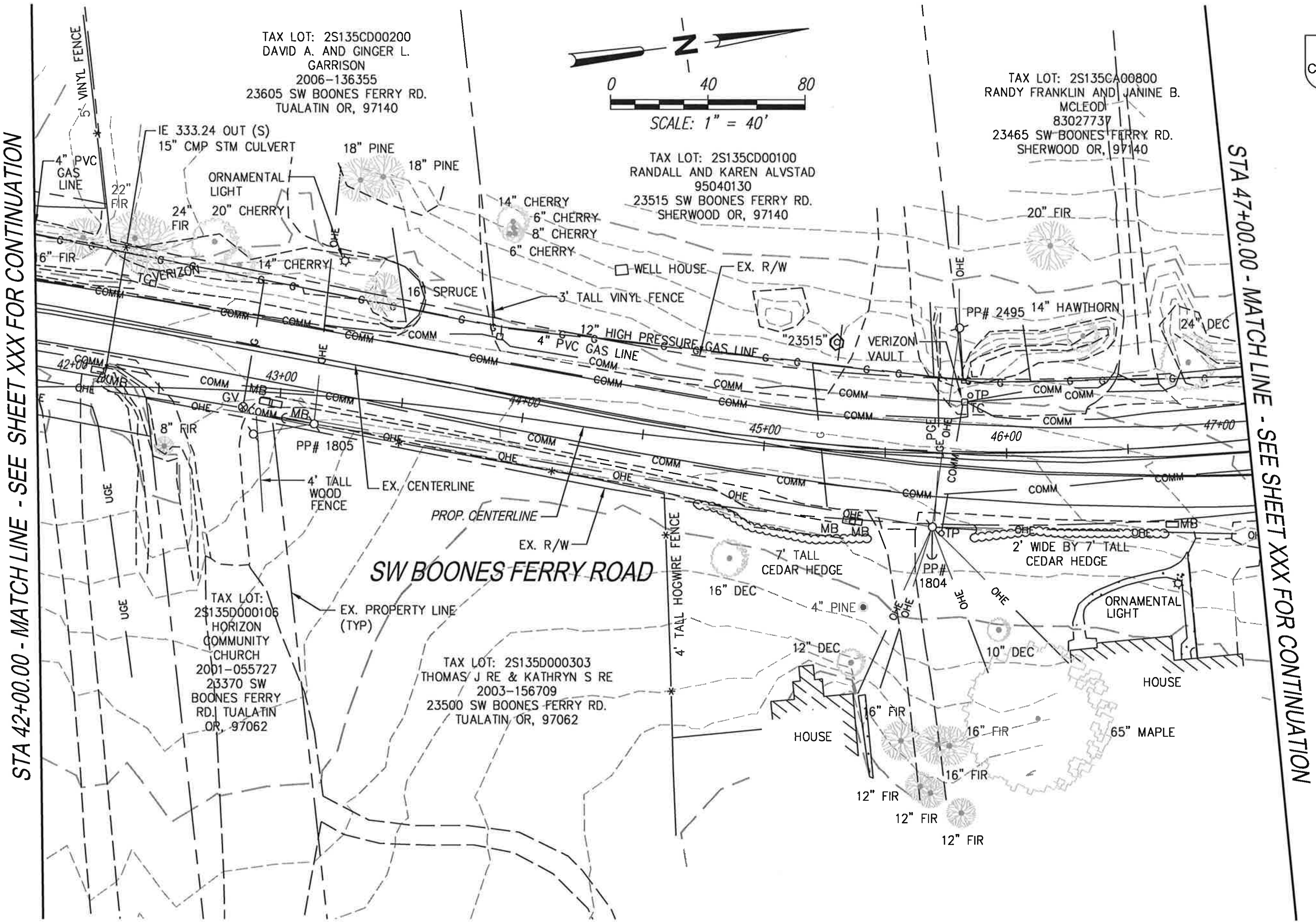
Appendix C



Lucini Tax Lot Information

[Background image from County Existing Conditons Plan June 2012.]

EXISTING CONDITIONS PLAN



REGISTERED PROFESSIONAL LAND SURVEYOR

OREGON
JUNE 11, 2008
CHRISTOFER C. SHERBY
74508LS

RENEW 6/30/12

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING

WASHINGTON COUNTY OREGON

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SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

EXISTING CONDITIONS PLAN

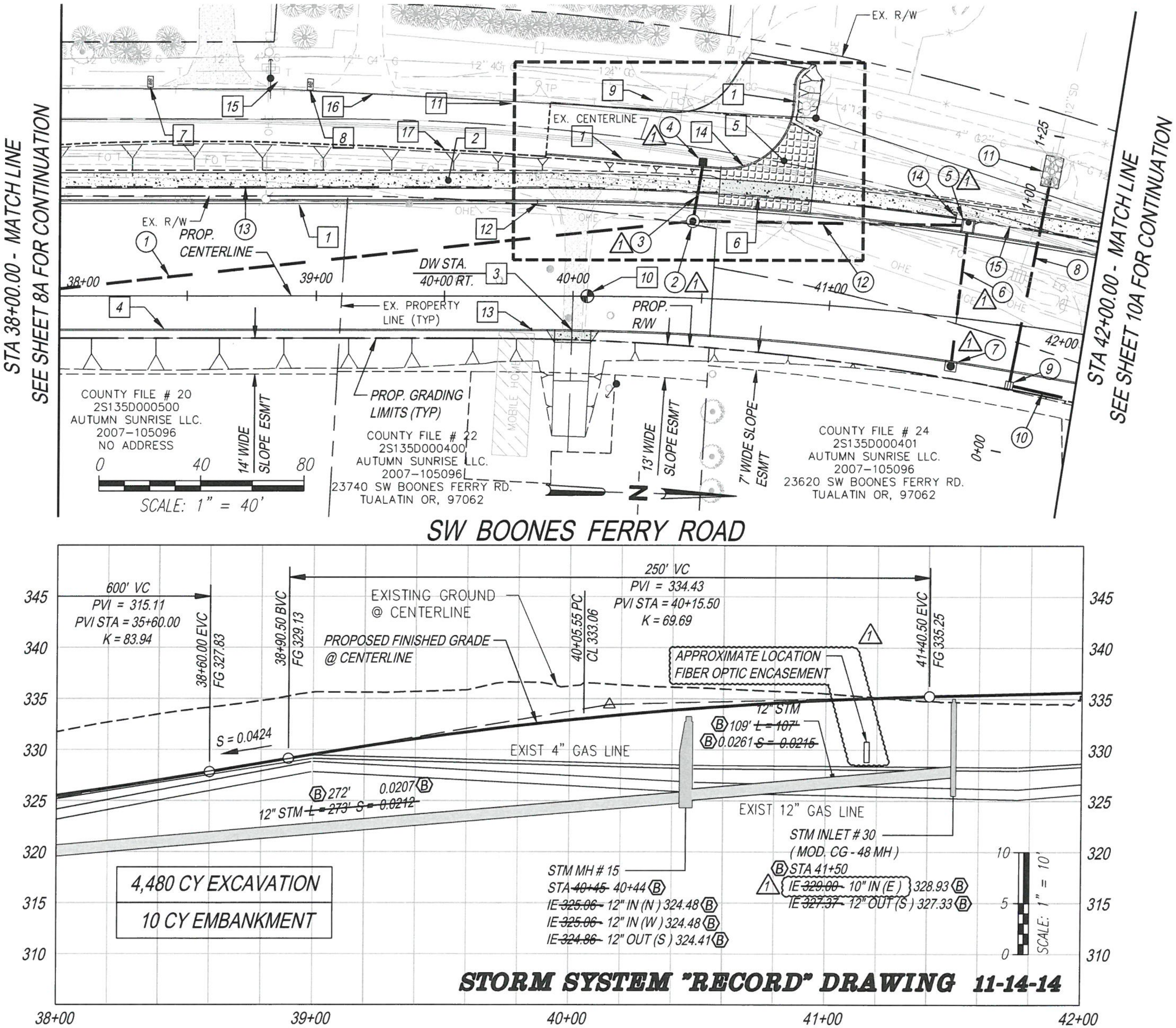
PROJECT NUMBER 100096

SHEET NO. 37 OF X

SHEET TITLE 2C-8

Appendix D

CONSTRUCTION PLAN AND PROFILE



REGISTERED PROFESSIONAL ENGINEER
15552PE
OREGON
JULY 25, 1994
DAMON C. WEBSTER
11/18/14
EXPIRES: 6/30/16

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING

WASHINGTON COUNTY OREGON

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NO.	REVISIONS	
1	REVISION NO. 3	5-20-2013 RRM
B	STORM SYSTEM "RECORD" DATA 11-14-14	

MacKay Sposito
ENERGY PUBLIC WORKS LAND DEVELOPMENT
www.mackaysposito.com

SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

CONSTRUCTION PLAN AND PROFILE

PROJECT NUMBER 100096
SHEET NO. 145 OF 274
SHEET TITLE 9A

CONSTRUCTION NOTES

THIS SHEET TO FACE SHT. 9A

[1] CONST. P.C. CONC. CURB & GUTTER
SEE SHEET 2B-4 FOR DETAILS

[2] CONST. POROUS P.C. CONC. WALK
SEE SHEET 2B-6 FOR DETAILS

[3] CONST. P.C. RESIDENTIAL DRIVEWAY
SEE SHEET 2B-1 & 2B-2 FOR DETAILS

[4] CONST. P.C. CONC. MOUNTABLE VERTICAL CURB
SEE SHEET 2B-4.1 FOR DETAILS

[5] INSTALL UNIT PAVERS AS SPECIFIED IN BOOK 2

[6] CONST. CONC. COMMERCIAL DRIVEWAY
SEE SHEET 2B-6 FOR DETAILS

[7] CONST. SINGLE MAILBOX
STATION 38+35
MB ADDRESS " 23845 "
SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS

[8] CONST. SINGLE MAILBOX
STATION 38+97
MB ADDRESS " 23745 "
SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS

[9] CONST. SINGLE MAILBOX
STATION 40+30
MB ADDRESS " 23677 "
SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS

[10] INSTALL CENTERLINE SURVEY MONUMENT
WITH FRAME AND COVER
@ STA 40+05.55 - CL PC
SEE SHEET NO 2B-7 FOR DETAIL

[11] SEE SHEET 17A FOR DETAIL
OF THIS AREA.

[12] 39+85.89 PC (37.00' LT)
TC 332.05

[13] 39+65.87 PC (13.00' RT)
TC 332.62

[14] CONST LOW PROFILE MOUNTABLE CURB
SEE SHEET 2B-6 FOR DETAILS

[15] POWER POLE BY PGE (TYP)

[16] OVERHEAD POWER BY PGE (TYP)

[17] SAWCUT EXIST AC PAVEMENT
AND REMOVE (N)

(1) 12" STM SEWER ~~L = 273' S = 0.0212~~ (B) 272' 0.0207 (B)

△1 (2) STM MH # 15
@ STA ~~40+45~~ (30' LT) 40+44 (B)
RIM = ~~333.22~~ 333.16 (B)
IE ~~325.06~~ 12" IN (N) 324.48 (B)
IE ~~325.06~~ ~~12" IN (W)~~ 324.48 (B)
10" IN (W) △1
IE 324.86 - 12" OUT (S) 324.41 (B)

△1 (3) ~~10" STM SEWER L = 23' S = 0.1270~~
△1 10" STM SEWER L = 23' ~~S = 0.2626~~
(B) 0.2535 (B)

△1 (4) STM CB # 29 (AREA DRAIN TYPE II)
@ STA ~~40+50~~ (53' LT) 40+47 (B)
~~TC 334.27~~ TOG 333.71 (B)
~~IE 330.00~~ - 10" OUT (E)
△1 IE ~~331.15~~ 330.31 (B)

△1 (5) STM CB # 30 (MOD. CG - 48 MH)
(B) @ STA 41+50 (36' LT)
RIM = ~~334.98~~ 334.95 (B)
~~IE 327.54 - 10" IN (E)~~ IE ~~329.00~~ 10" IN (E) △1 328.93 (B)
IE ~~327.37~~ 12" OUT (S) 327.33 (B)

△1 (6) 10" STM SEWER ~~L = 58' S = 0.0483~~ L = 54' ~~S = 0.0100~~ △1
(B) 0.0081 (B)

△1 (7) STM CB # 31 (CG-30)
(B) @ STA 41+50 (22' RT)
TC ~~335.32~~ 335.38 (B)
~~IE 330.32 - 10" OUT (W)~~ IE ~~329.54~~ - 10" OUT (W) △1 329.37 (B)

(8) 12" STM CULVERT ~~L = 83' S = 0.0162~~
STM OUTFALL #5 (B) 80' 0.0148 (B)

(9) STM INLET # 32 (DITCH INLET)
(B) @ STA 41+74 (24' RT)
~~TC 335.45~~ RIM 334.66 (BOTTOM OF GRATE) (B)
IE ~~330.81~~ - 12" IN (N) 331.11 (B)
IE ~~330.61~~ - 12" OUT (W) 330.55 (B)

(10) 12" STM SEWER ~~L = 77'~~ S = 0.0101
(B) 74' (B)

(11) RIP RAP PAD
CLASS 50 RIP RAP
8' LONG x 7' WIDE x 1.5' DEEP
PLACE 1' ABOVE PIPE CROWN

(12) 12" STM SEWER ~~L = 107' S = 0.0215~~
(B) 109' 0.0261 (B)

(13) 4" PP STM SEWER L = 373'

(14) STA 41+45 (39' LT)
PLUG 4" PP

(15) 4" PP STM SEWER L = 349'

STORM SYSTEM "RECORD" DRAWING 11-14-14

REGISTERED PROFESSIONAL ENGINEER 15552PE
OREGON
JULY 25, 1991
DAMON C. WEBSTER
11/18/14
EXPIRES: 6/30/16

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING
WASHINGTON COUNTY OREGON

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NO.	REVISIONS	
△1	REVISION NO. 3	5-20-2013 RRM
(B)	STORM SYSTEM "RECORD" DATA 11-14-14	

SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

CONSTRUCTION NOTES

MacKay Sposito
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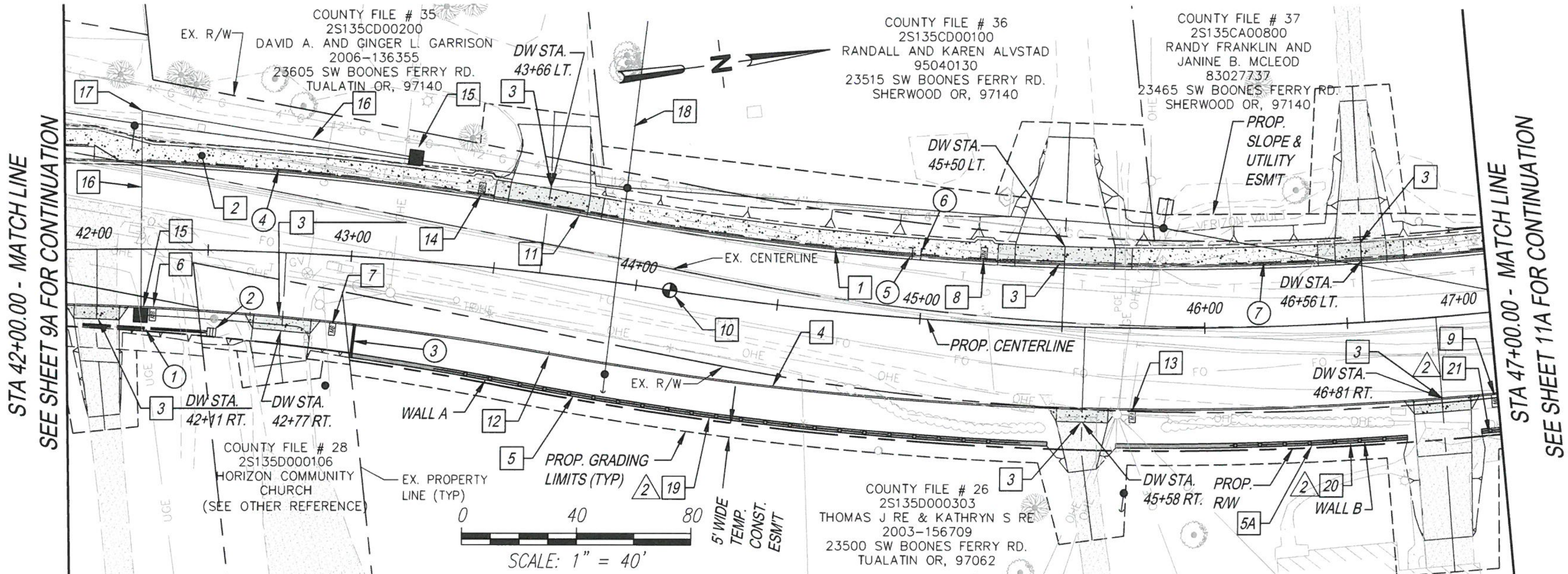
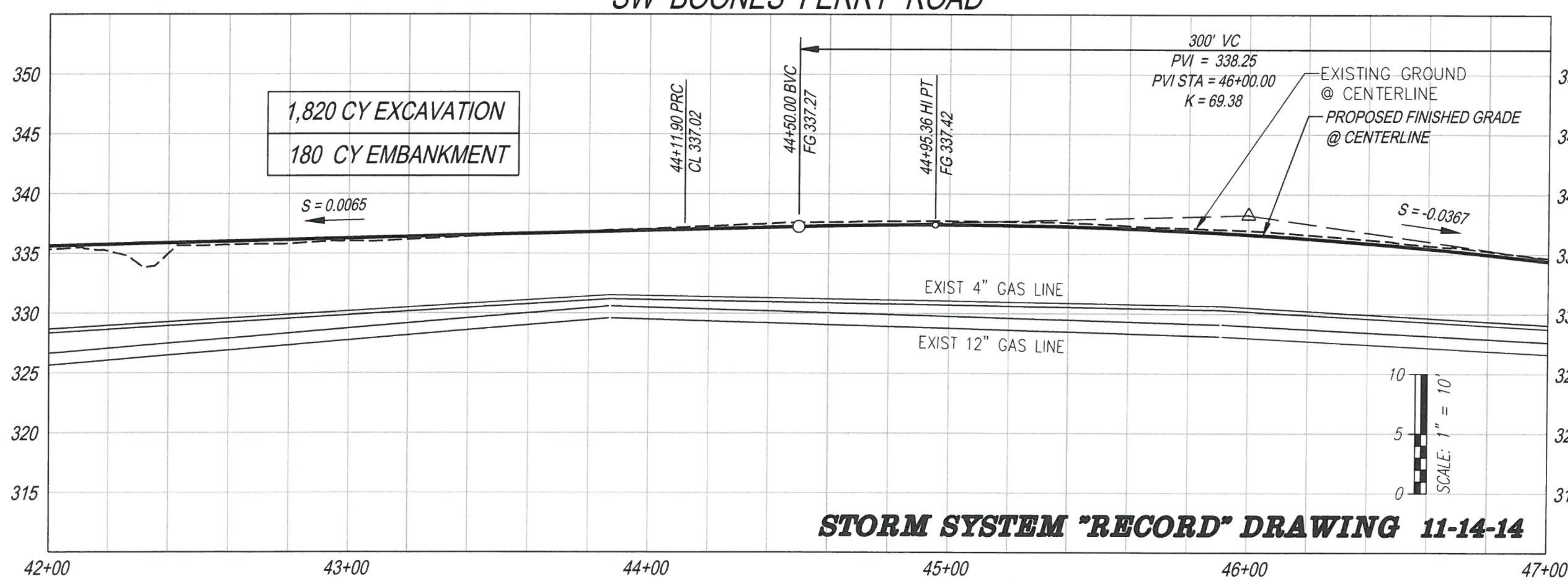
PROJECT NUMBER 100096
SHEET NO. 144 OF 274
SHEET TITLE 9

CONSTRUCTION PLAN AND PROFILE



SW BOONES FERRY ROAD



STORM SYSTEM "RECORD" DRAWING 11-14-14

REGISTERED PROFESSIONAL ENGINEER 15552PE OREGON JULY 25, 1981 RAMON C. WEBSTER 11/18/14
EXPIRES: 6/30/16

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING
WASHINGTON COUNTY OREGON

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NO.	REVISIONS	
2	ADDENDUM NO. 2	RRM 4-16-2013
B	STORM SYSTEM "RECORD" DATA 11-14-14	

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SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY
CONSTRUCTION PLAN AND PROFILE

PROJECT NUMBER 100096
SHEET NO. 147 OF 274
SHEET TITLE 10A

CONSTRUCTION NOTES

THIS SHEET TO FACE SHT. 10A

1. CONST. P.C. CONC. CURB & GUTTER
   SEE SHEET 2B-4 FOR DETAILS
2. CONST. POROUS P.C. CONC. WALK
   SEE SHEET 2B-6 FOR DETAILS
3. CONST. P.C. RESIDENTIAL DRIVEWAY
   SEE SHEET 2B-1 & 2B-2 FOR DETAILS
4. CONST. P.C. CONC. MOUNTABLE VERTICAL CURB
   SEE SHEET 2B-4.1 FOR DETAILS
5. CONST. PREFAB. MODULAR RETAINING WALL A
   SEE SHEET 28A FOR DETAILS

5A. CONST. PREFAB. MODULAR RETAINING WALL B
   SEE SHEET 28A FOR DETAILS

6. CONST. SINGLE MAILBOX
   STATION 42+31
   MB ADDRESS " 23620 "
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
7. CONST. DOUBLE MAILBOX
   STATION 42+95
   MB ADDRESS " 23560 "
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
8. CONST. SINGLE MAILBOX
   STATION 45+21
   MB ADDRESS " 23515 "
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
9. CONST. SINGLE MAILBOX
   STATION 46+99
   MB ADDRESS " 23500 "
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
10. INSTALL CENTERLINE SURVEY MONUMENT
    WITH FRAME AND COVER
    @ STA 44+11.90 - CL PRC
    SEE SHEET NO 2B-7 FOR DETAIL
11. 43+77.26 PRC (22.52' LT)
    TC 336.58
12. 43+58.83 PRC (34.82' LT)
    TC 336.30
13. CONST. SINGLE MAILBOX
    STATION 45+75
    MB ADDRESS " 23550 "
    SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
14. CONST. SINGLE MAILBOX
    STATION 43+43
    MB ADDRESS " 23605 "
    SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
15. PROPOSED POWER VAULT BY PGE
16. PROPOSED POWER CONDUIT BY PGE
17. POWER POLE BY PGE (TYP)
18. OVERHEAD POWER BY PGE (TYP)
19. BLACK VINYL COATED CHAINLINK FENCE
    WALL A: STA. 0+30 TO STA. 2+37
    △2 ~~3" FROM BACK OF WALL~~
    REFER TO ODOT STD DRAWING
    RD815. INSTALL FENCE ON WALL.
20. BLACK VINYL COATED CHAINLINK FENCE
    WALL B: STA. 0+40 TO STA. 1+12
    △2 ~~3" FROM BACK OF WALL~~
    REFER TO ODOT STD DRAWING
    RD815. INSTALL FENCE ON WALL.
21. BLACK VINYL COATED CHAINLINK FENCE
    WALL C: STA. 0+00 TO STA. 0+36
    △2 ~~3" FROM BACK OF WALL~~
    REFER TO ODOT STD DRAWING
    RD815. INSTALL FENCE ON WALL.

(1) 12" STM SEWER ~~L = 77'~~ Ⓑ74' S = 0.0101 Ⓑ
(2) STM INLET # 33 (DITCH INLET)
    @ STA ~~42+52~~ (29' RT) 42+50 Ⓑ
    ~~TC 335.83~~ RIM 334.68 (BOTTOM OF GRATE) Ⓑ
    IE ~~331.58~~ - 12" OUT (S) 331.86 Ⓑ
(3) 4" D.I.P. FOOTING DRAIN CONNECTION
    THRU CURB FACE - L = 12' UNABLE TO VERIFY
(4) 4" PP STM SEWER L = 349'
(5) STA 44+95 (23' LT)
    PLUG 4" PP
(6) STA 44+98 (23' LT)
    PLUG 4" PP
(7) 4" PP STM SEWER L = 335'

STORM SYSTEM "RECORD" DRAWING 11-14-14

REGISTERED PROFESSIONAL ENGINEER 15552PE OREGON JULY 25, 1990 DAMON C. WEBSTER 11/18/14
EXPIRES: 6/30/16

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING
WASHINGTON COUNTY OREGON

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NO.	REVISIONS	
△2	ADDENDUM NO 2	RRM 4-16-2013
Ⓑ	STORM SYSTEM "RECORD" DATA 11-14-14	

SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

CONSTRUCTION NOTES

PROJECT NUMBER 100096
SHEET NO. 146 OF 274
SHEET TITLE 10

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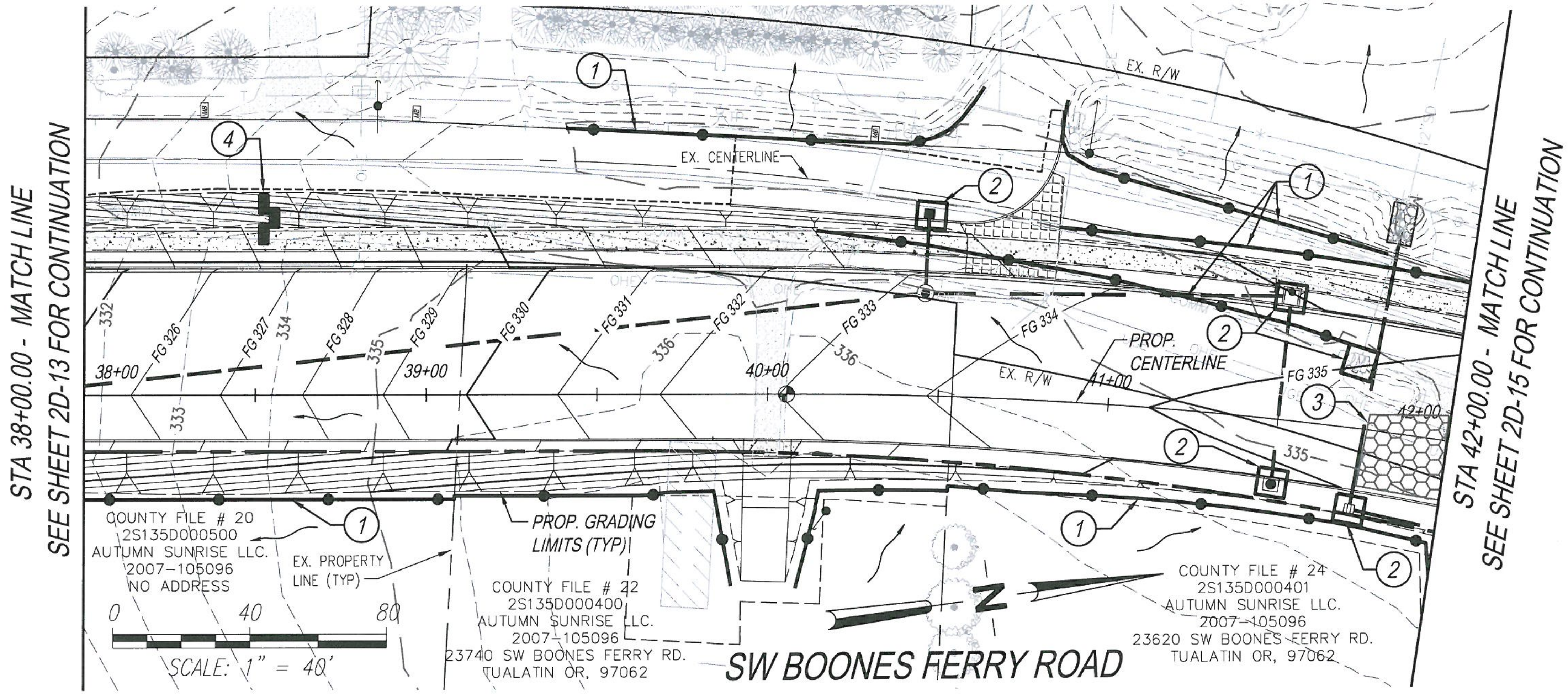
Appendix E

EROSION & SEDIMENT CONTROL PLAN



LEGEND

- - - -280- - - -	EXISTING CONTOUR
——FG 281——	FINISHED CONTOURS (MINOR)
——FG 280——	FINISHED CONTOURS (MAJOR)
——•——	SILT FENCE
	CHECK DAM BIO-FILTER BAG
	DIRECTION OF FLOW
	TEMPORARY STORM INLET PROTECTION
	GRAVEL CONSTRUCTION ENTRANCE

EROSION & SEDIMENT CONTROL NOTES

1. CONSTRUCT SEDIMENT FENCE
   SEE SHEET 2D-3 & 2D-4 FOR DETAILS
2. CONSTRUCT INLET PROTECTION
   SEE SHEET 2D-4 FOR DETAILS
3. CONSTRUCT GRAVEL CONSTRUCTION ENTRANCE
   SEE SHEET 2D-3 FOR DETAILS
4. CONSTRUCT CHECK DAM BIO-FILTER BAG
   SEE SHEET 2D-3 FOR DETAILS

"RECORD" DRAWING 11-14-14

NOTE:
EROSION AND SEDIMENT CONTROLS SELECTION AND PLACEMENT MUST BE CONSISTENT AND APPROPRIATE FOR CONSTRUCTION PHASING AT ALL TIMES. CONTROLS SHOWN ON PLANS MAY NOT APPLY TO ALL CONSTRUCTION PHASES.

REGISTERED PROFESSIONAL ENGINEER
15552PE
OREGON
JULY 25, 1991
AMON C. WEBSTER
1/31/13
EXPIRES: 6/30/14

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING
WASHINGTON COUNTY OREGON

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NO.	REVISIONS

SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

EROSION & SEDIMENT CONTROL PLAN

MacKay Sposito
ENERGY PUBLIC WORKS LAND DEVELOPMENT
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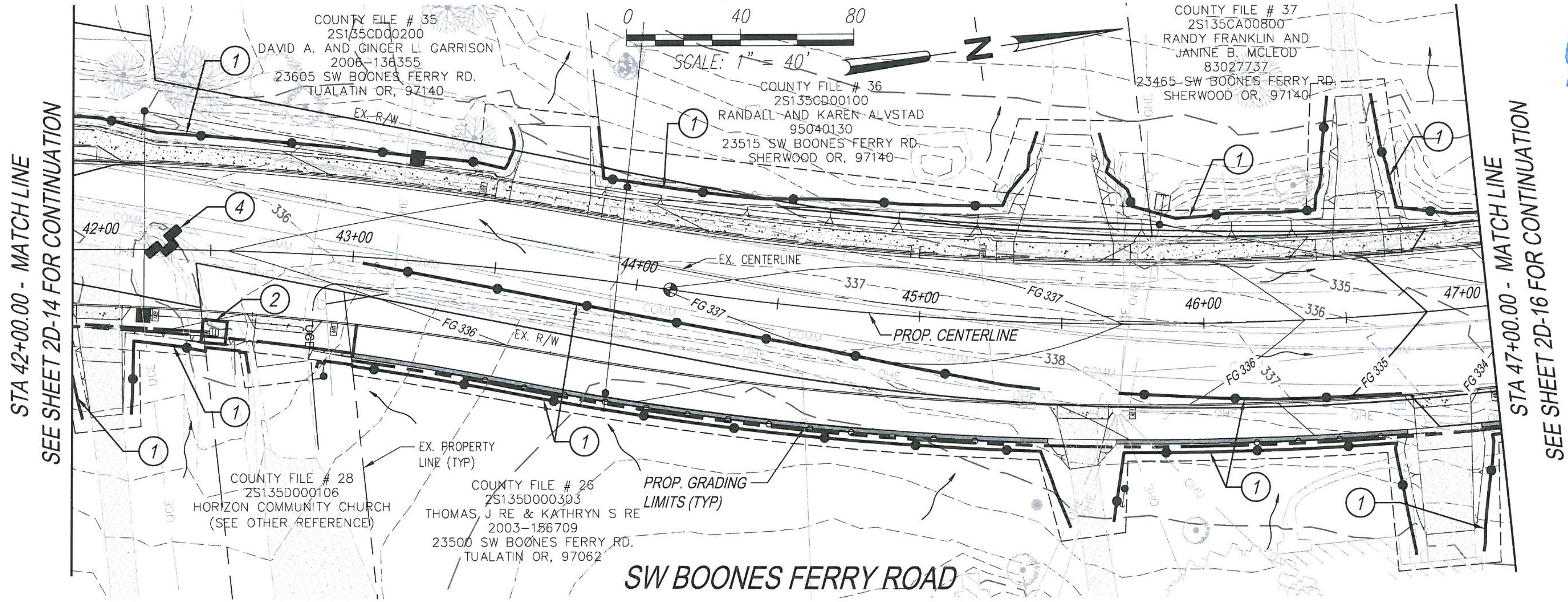
PROJECT NUMBER 100096
SHEET NO. 80 OF 274
SHEET TITLE 2D-14

EROSION & SEDIMENT CONTROL PLAN



LEGEND

— — —280— — —	EXISTING CONTOUR
——FG 281——	FINISHED CONTOURS (MINOR)
——FG 280——	FINISHED CONTOURS (MAJOR)
——●——	SILT FENCE
	CHECK DAM BIO-FILTER BAG
	DIRECTION OF FLOW
	TEMPORARY STORM INLET PROTECTION
	GRAVEL CONSTRUCTION ENTRANCE

EROSION & SEDIMENT CONTROL NOTES

1. CONSTRUCT SEDIMENT FENCE
SEE SHEET 2D-3 & 2D-4 FOR DETAILS
2. CONSTRUCT INLET PROTECTION
SEE SHEET 2D-4 FOR DETAILS
3. CONSTRUCT GRAVEL CONSTRUCTION ENTRANCE
SEE SHEET 2D-3 FOR DETAILS
4. CONSTRUCT CHECK DAM BIO-FILTER BAG
SEE SHEET 2D-3 FOR DETAILS

"RECORD" DRAWING 11-14-14

NOTE:
EROSION AND SEDIMENT CONTROLS SELECTION AND PLACEMENT MUST BE CONSISTENT AND APPROPRIATE FOR CONSTRUCTION PHASING AT ALL TIMES. CONTROLS SHOWN ON PLANS MAY NOT APPLY TO ALL CONSTRUCTION PHASES.

REGISTERED PROFESSIONAL ENGINEER 15552PE
OREGON
JULY 25, 1991
DAMON C. WEBSTER
1/31/13
EXPIRES: 6/30/14

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING
WASHINGTON COUNTY OREGON

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NO.	REVISIONS

SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

EROSION & SEDIMENT CONTROL PLAN

MacKay Sposito
ENERGY PUBLIC WORKS LAND DEVELOPMENT
www.mackaysposito.com

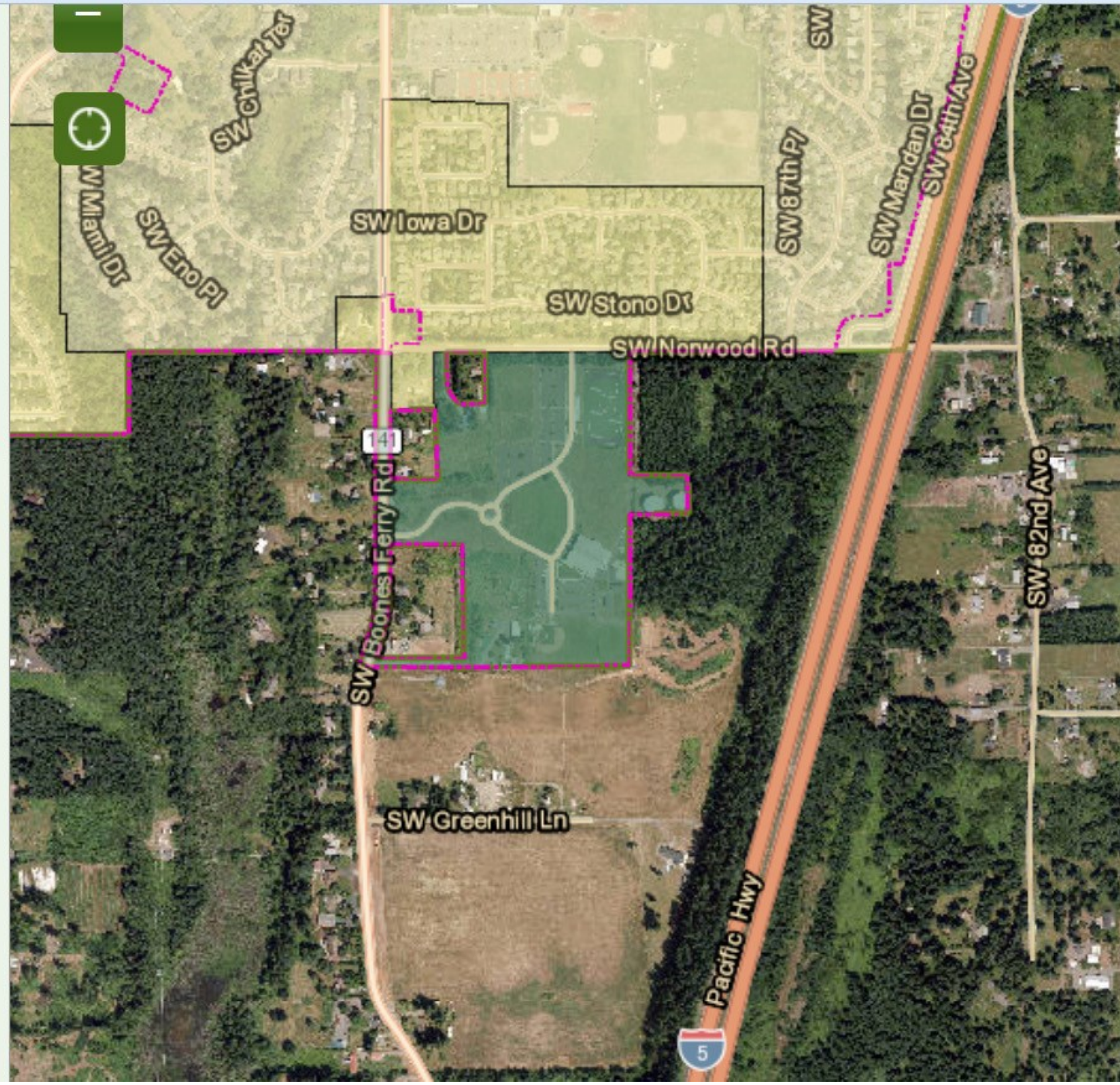
PROJECT NUMBER 100096
SHEET NO. 81 OF 274
SHEET TITLE 2D-15

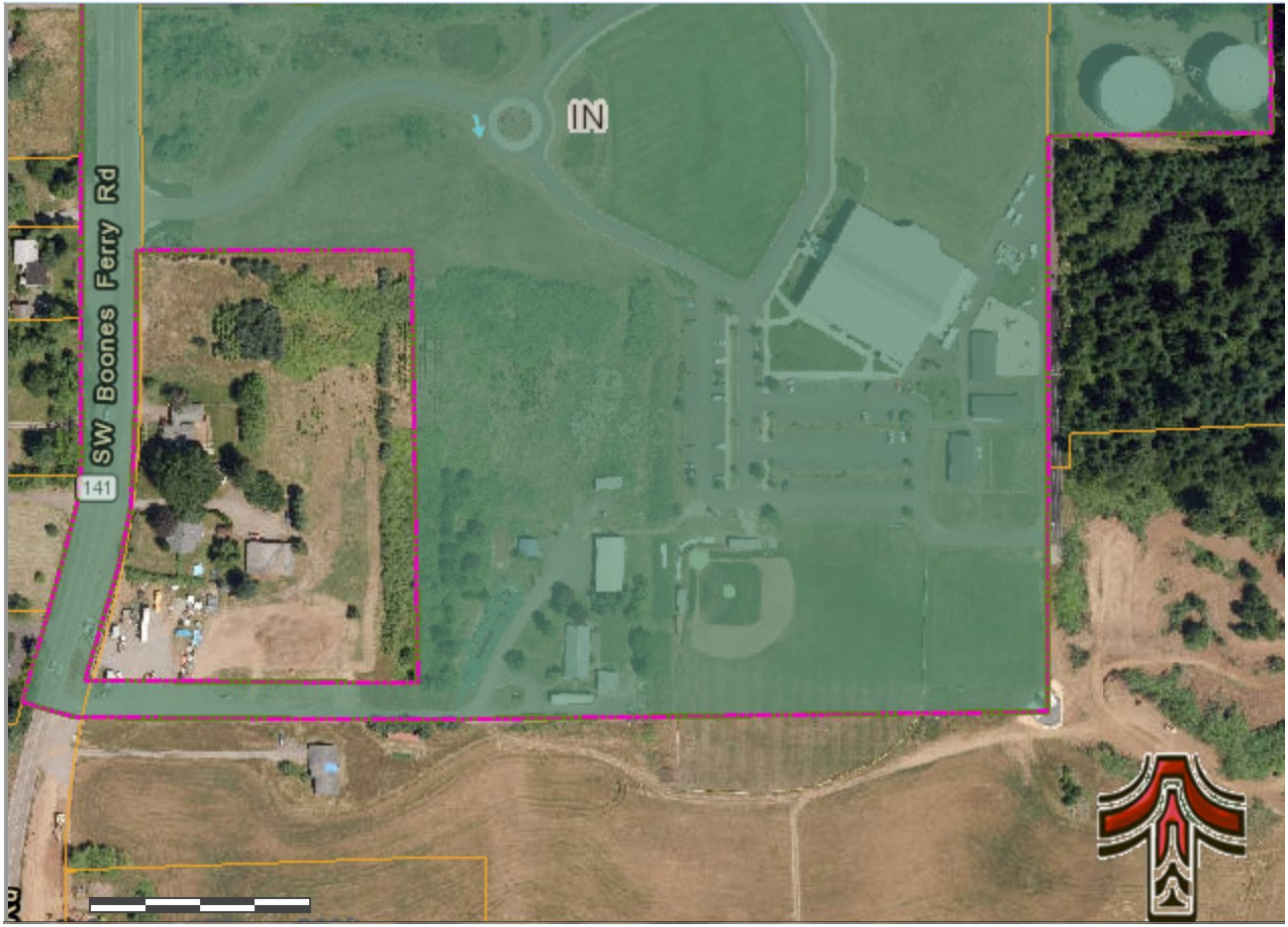
Appendix F

Tualatin Planning Districts

Planning Districts

- Commercial Office (CO)
- Central Commercial (CC)
- General Commercial (CG)
- Recreational Commercial (CR)
- Medical Commercial (MC)
- Light Manufacturing (ML)
- General Manufacturing (MG)
- Manufacturing Park (MP)
- Manufacturing Business Park (MBP)
- Low Density Residential (RL)
- Medium Low Density Residential
- Medium High Density Residential (RMH)
- High Density Residential (RH)
- High Density/High Rise Residential (RH/HR)
- Institutional (IN)

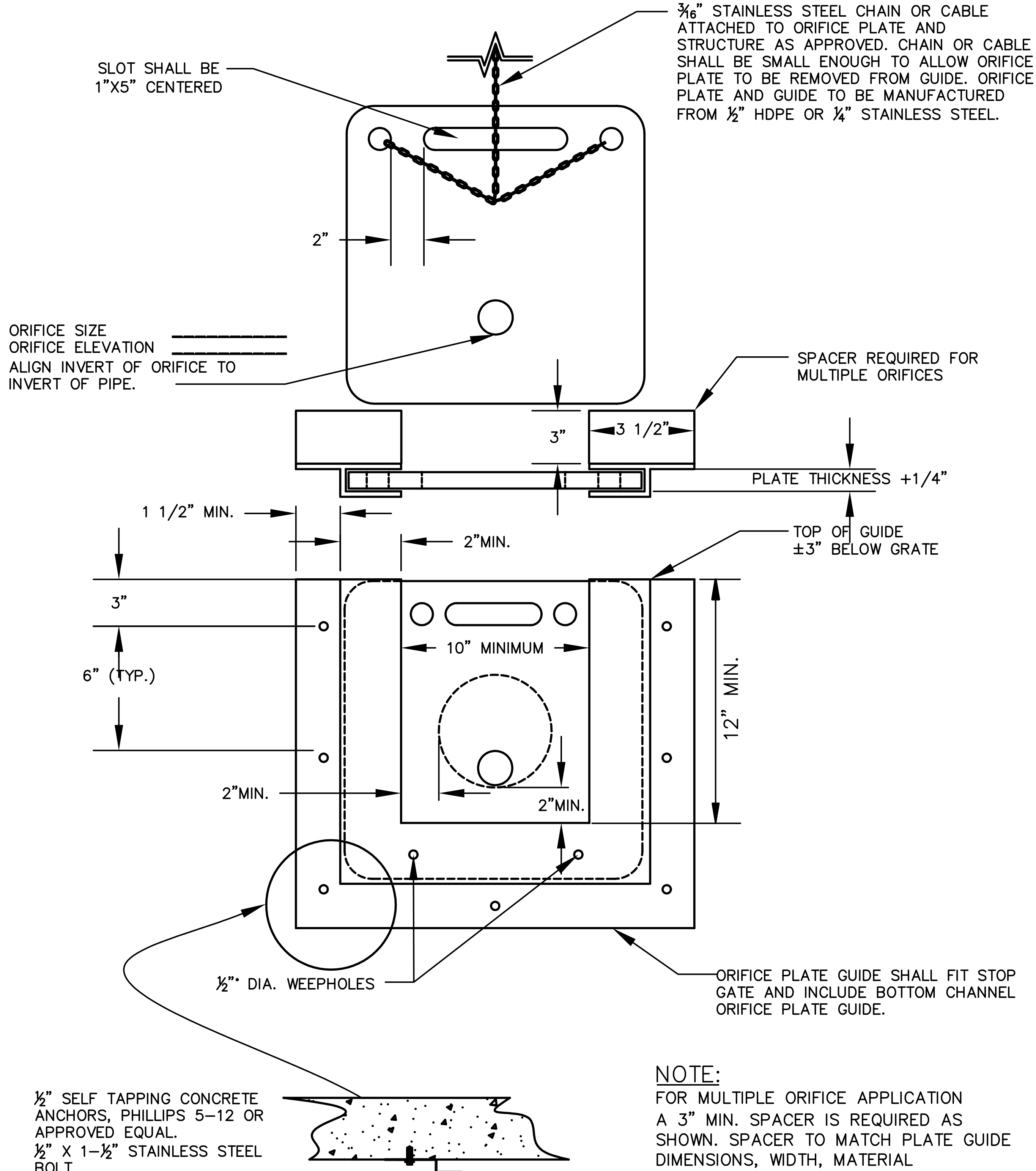




IN
SW Boones Ferry Rd
141


141
23643
SW Boones Ferry Rd

Appendix G



NOTE:

FOR MULTIPLE ORIFICE APPLICATION A 3" MIN. SPACER IS REQUIRED AS SHOWN. SPACER TO MATCH PLATE GUIDE DIMENSIONS, WIDTH, MATERIAL WITH A WATER TIGHT SEAL.

ORIFICE PLATE AND GUIDE

REVISED 12–06

Clean Water Services
Our commitment is clear.

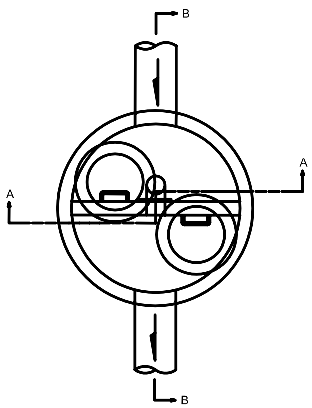
DRAWING NO. 730

FLOW CONTROL STRUCTURE DETAIL

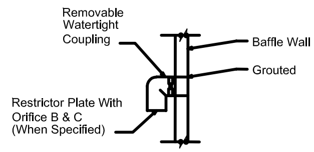
DRAWING NO. 270

REVISED 12-06

Clean Water Services
Our commitment is clear.



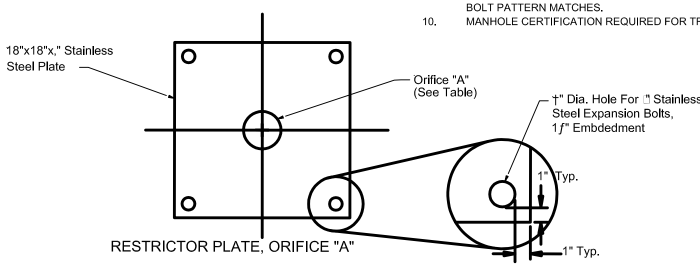
PLAN



ELBOW DETAIL

NOTES:

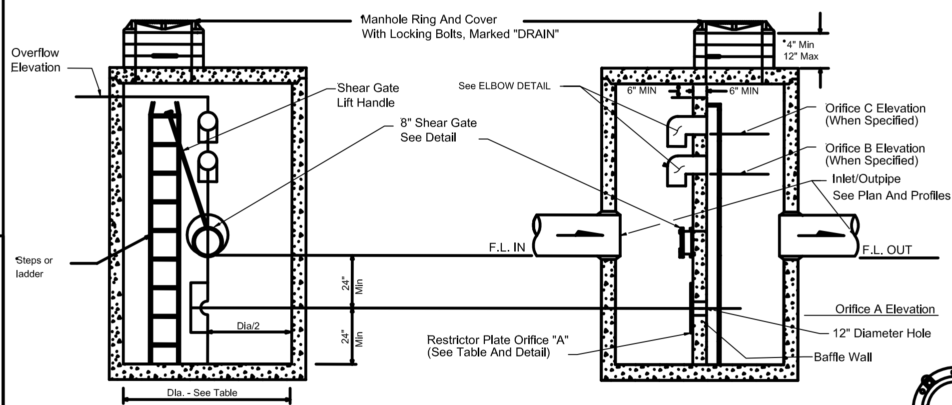
1. BAFFLE WALL SHALL HAVE #4 BAR AT 12" SPACING EACH WAY.
2. PRECAST BAFFLE SHALL BE KEYED AND GROUTED IN PLACE. JOINT BETWEEN CONCRETE BAFFLE AND MANHOLE WALL SHALL BE WATERTIGHT.
3. UPPER FLOW ORIFICE SHALL BE ALUMINUM, ALUMINIZED STEEL OR GALVANIZED STEEL. GALVANIZED STEEL SHALL HAVE TREATMENT 1.
4. FRAME AND LADDER OR STEPS ARE TO BE OFFSET SO THAT: SHEAR GATE IS VISIBLE FROM THE TOP; CLIMB-DOWN SPACE IS CLEAR OF RISER AND GATE; FRAME IS CLEAR OF CURB.
5. MULTI-ORIFICE ELBOWS SHALL BE PREINSTALLED TO INSURE LADDER CLEARANCE.
6. RESTRICTOR PLATE WITH ORIFICE AS SPECIFIED IN THE CONTRACT. OPENING IS TO BE CUT ROUND AND SMOOTH. NEOPRENE GASKET SHALL BE INSTALLED BETWEEN THE ORIFICE PLATE AND CONCRETE BAFFLE TO PROVIDE A WATERTIGHT SEAL.
7. SHEAR GATE SHALL BE MADE OF ALUMINUM ALLOY IN ACCRDANCE WITH ASTM B 26M AND ASTM B 275, DESIGNATION Zg32A 0R CAST IRON IN ACCORDANCE WITHASTM A 48, CLASS 30B. LIFT HANDLE MAY BE SOLID ROD OR HOLLOW TUBING WITH ADJUSTABLE HOOK AS REQUIRED. NEOPRENE RUBBER GASKET RERQUIRED BETWEEN RISER MOUNTING FLANGE AND GATE FLANGE. MATING SURFACES OF LID AND BODY SHALL BE MACHINED FOR PROPER FIT. FLANGE MOUNTING BOLTS SHALL BE....."DIAMETER STAINLESS STEEL.
8. SHEAR GATE MAXIMUM OPENING SHALL BE CONTROLLED BY LIMITED HINGE MOVEMENT, STOP TAB OR SOME OTHER DEVISE.
9. ALTERNATE SHEAR GATES DESIGNS AREACCEPTABLE, IF MATERIAL SPECIFICATIONS ARE MET AND FLANGE BOLT PATTERN MATCHES.
10. MANHOLE CERTIFICATION REQUIRED FOR TRAFFIC LOADING.



RESTRICTOR PLATE, ORIFICE "A"

FLOW CONTROL STRUCTURE TABLE

Diameter Of Manhole (In.)	
F.L. (In)	
F.L. (Out)	
Outlet Pipe Diameter (In.)	
Number Of Orifice	
Orifice A Elevation	
Diameter Of Orifice A (In.)	
Orifice B Elevation	
Diameter Of Orifice B (In.)	
Orifice C Elevation	
Diameter Of Orifice C (In)	
Overflow Elevation	
Rim Elevation	
Riser Diameter (In.)	



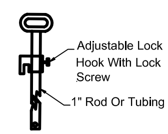
SECTION A-A

ELEVATION

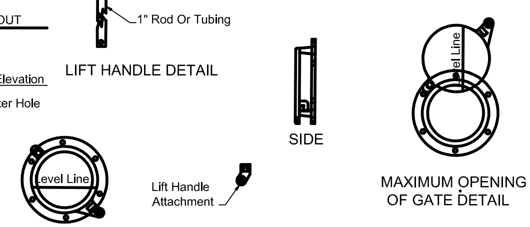
SECTION B-B

FLOW CONTROL STRUCTURE DETAIL

NTS



LIFT HANDLE DETAIL



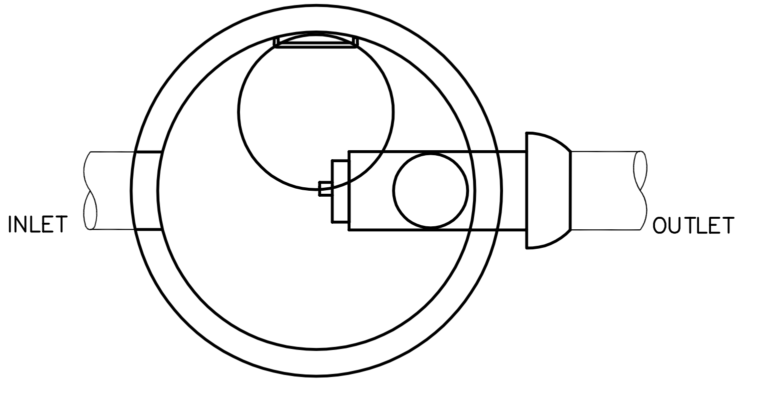
FRONT

MAXIMUM OPENING OF GATE DETAIL

SHEAR GATE
AS MANUFACTURED BY KENNEDY VALVE OR EQUAL

DRAINAGE DETAILS

NOTES:
1. ALL MANHOLE SECTIONS SHALL CONFORM TO THE REQUIREMENTS OF ASTM C-478 AND APPLICABLE PROVISIONS OF STD. MANHOLE DRAWING NO. 010
2. INLET AND OUTLET PIPE NOT TO EXCEED 18"DIA.
3. PROVIDE SPECIAL DETAIL FOR OUTLET FLOW CONTROL EXCEEDING 18" DIA.
4. ALL OUTLETS SHALL HAVE FLOW CONTROL DEVICE.



PLAN

SUMP VOLUME AVAILABLE

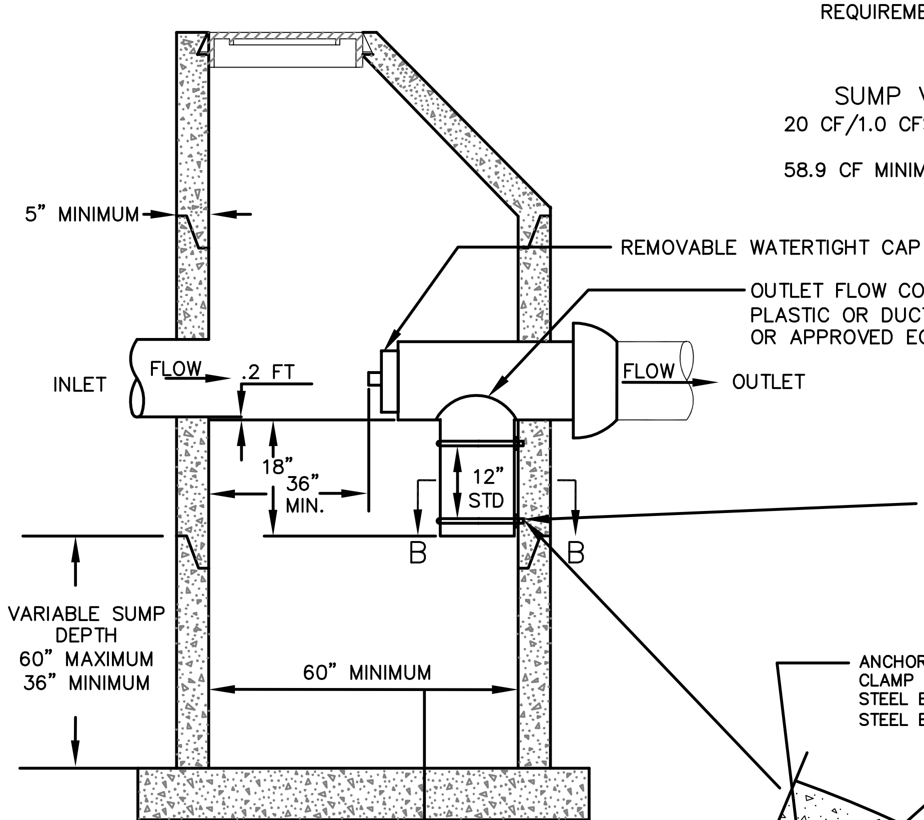
	MINIMUM	MAXIMUM
60" M.H.=	58.9 CF	98.1 CF
72" M.H.=	84.8 CF	141.3 CF
84" M.H.=	115.4 CF	192.3 CF

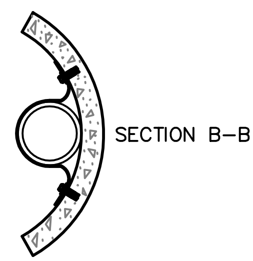
PROVIDE SPECIAL DETAIL FOR VOLUME REQUIREMENTS EXCEEDING 192.3 CF

SUMP VOLUME REQUIREMENTS

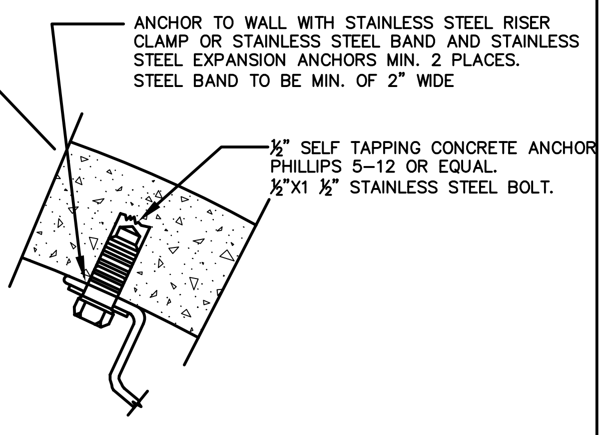
20 CF/1.0 CFS OF INFLOW

58.9 CF MINIMUM REQUIRED





MANHOLE DIAMETER TO BE DETERMINED BY:
1. SUMP VOLUME REQUIREMENTS.
2 NUMBER AND SIZE OF INLETS & OUTLETS.



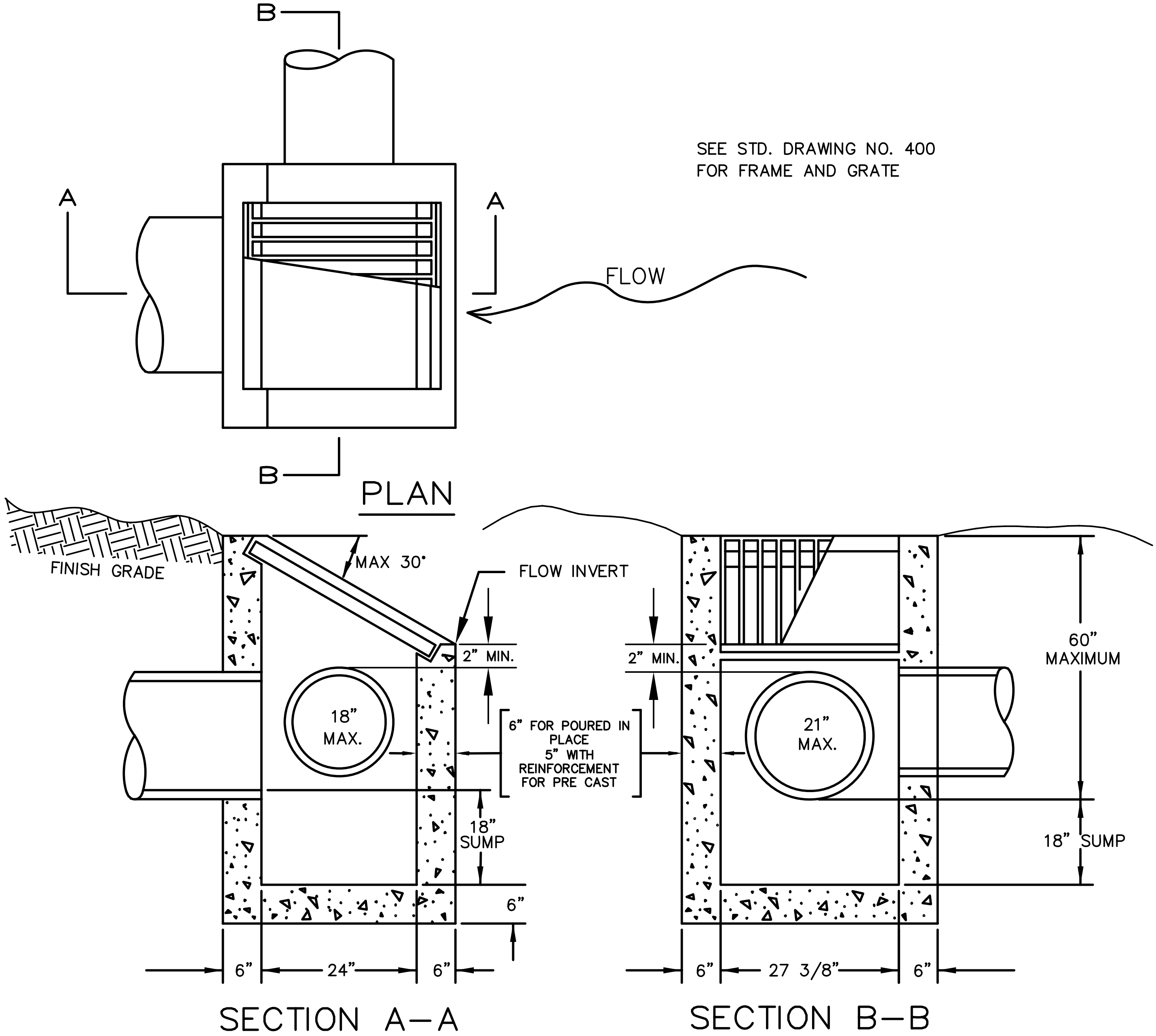
CLAMP DETAIL
(SECTION A-A)
N.T.S.

WATER QUALITY MANHOLE (MECHANICAL)

DRAWING NO. 240

REVISED 12-06

Clean Water Services
Our commitment is clear.



NOTES:

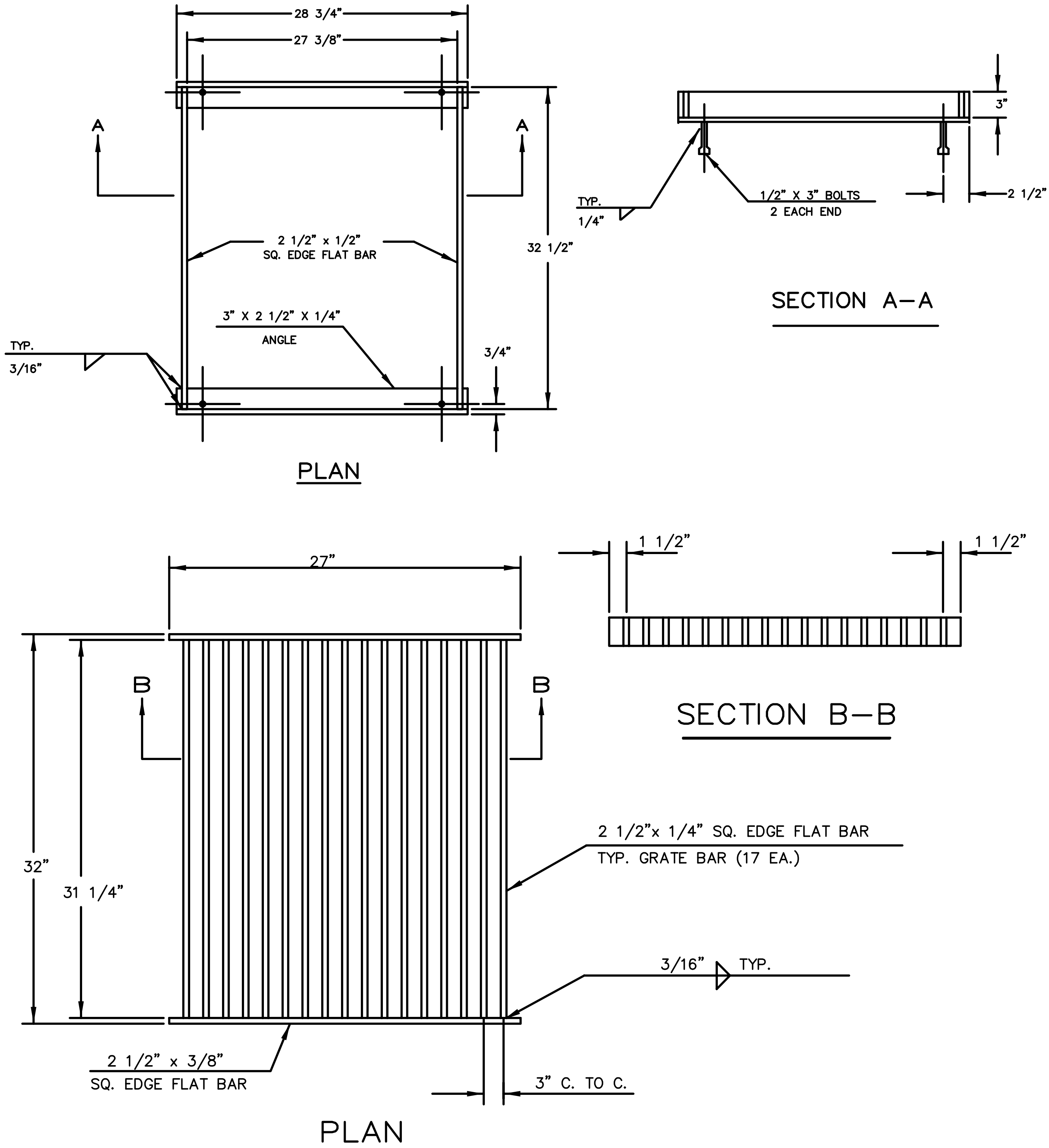
1. ALL PRE CAST SECTIONS SHALL CONFORM TO REQUIREMENTS OF ASTM C–478.
2. INSTALL STRUCTURE ON MINIMUM OF 8" OF 3/4" – 0" COMPACTED BASE MATERIAL.
3. PRE CAST REINFORCEMENT SHALL BE REBAR MEETING ASTM A615 GRADE 60 OR WELDED WIRE MEETING ASTM A497
4. ALL POURED IN PLACE CONCRETE SHALL HAVE A 28 DAY STRENGTH OF 3000 PSI AND SLUMP OF 2" TO 4".
5. PRE–CAST STRUCTURE'S CONFORMING TO O.D.O.T. TYPE G–2 CATCH BASIN DESIGN/WITH DITCH INLET TOP ARE AN ACCEPTABLE ALTERNATE. ALL GRATE MATERIALS SHALL MEET C.W.S. STANDARDS AS SHOWN ON DETAIL #400

DITCH INLET

DRAWING NO. 390

REVISED 05–07

Clean Water Services
Our commitment is clear.



NOTE:
FRAME AND GRATE SHALL BE NEW STRUCTURAL ASTM A–36 FLAT BAR STEEL OR APPROVED EQUAL.

DITCH INLET FRAME AND GRATE

DRAWING NO. 400

REVISED 12–06

Clean Water Services
Our commitment is clear.

Appendix H

Summary for Subcatchment 17S: Ex Aux 5

Runoff = 1.17 cfs @ 8.13 hrs, Volume= 0.581 af, Depth= 1.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25yr Rainfall=3.90"

Area (ac)	CN	Description
0.200	98	Paved roads w/curbs & sewers, HSG B
4.000	65	2 acre lots, 12% imp, HSG B
1.600	74	Farmsteads, HSG B
5.800	69	Weighted Average
5.120		88.28% Pervious Area
0.680		11.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0100	0.09		**Sheet Flow, Field** Cultivated: Residue>20% n= 0.170 P2= 2.50"
6.5	500	0.0200	1.27		**Shallow Concentrated Flow, Field** Cultivated Straight Rows Kv= 9.0 fps
0.5	100	0.0400	3.22		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
0.6	105	0.0400	3.00		**Shallow Concentrated Flow, Grass** Grassed Waterway Kv= 15.0 fps
16.9	755	Total			

From County Storm Drainage Report for SW Boones Ferry Road (Jan 2013),
PDF Page 59 of 152.

Table LU_a. ORIGINAL Subbasin Areas with Future Land Use Conditions

Weighted Curve Numbers used in HEC-HMS Hydrologic Modeling for Varying Land Use Cases

Weighted average CN Calculations

Area (ac)	CN	Description		
0.200	98	Paved roads w/curbs & sewers, HSG B		
4.000	65	2 acre lots, 12% imp, HSG B [At 4 acres this is two lots that are 2 acres each.]		
1.600	74	Farmsteads, HSG B	Calibration-Check Washington County (OK)	
5.8	69	Weighted Average		68.6

Ongoing Land Use (LU)

Area (ac)	CN	Description		
0.200	98	Paved roads w/curbs & sewers, HSG B		
2.000	65	2 acre lot, 12% imp, HSG B		
2.000	92	Urban Districts: Commercial and Business		
1.600	74	Farmsteads, HSG B		LU Case CN
5.8	77.9	Weighted Average	Weighted Average CN	77.9

Full Build-out (BO)

Area (ac)	CN	Description		
0.200	98	Paved roads w/curbs & sewers, HSG B		
2.000	85	2 acre lot, 12% imp, HSG B		
2.000	92	Urban Districts: Commercial and Business		
1.600	85	Residential Districts: 1/8 acre		BO Case CN
5.8	87.9	Weighted Average	Weighted Average CN	87.9

Global Summary Results for Run "Lucini_o_17S"

Project: BF_o_Lucini Simulation Run: Lucini_o_17S

Start of Run:	01Jan3000, 00:00	Basin Model:	Above_Lucini
End of Run:	02Jan3000, 00:10	Meteorologic Model:	Met 1
Compute Time:	30Aug2016, 11:57:36	Control Specifications:	Control 1

Show Elements: All Elements Volume Units: (•) IN ( ) AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Lucini_o_17S	0.009048	1.17	01Jan3000, 08:06	1.20

Summary Results for Subbasin "Lucini_o_17S"

Project: BF_o_Lucini Simulation Run: Lucini_o_17S
Subbasin: Lucini_o_17S

Start of Run:	01Jan3000, 00:00	Basin Model:	Above_Lucini
End of Run:	02Jan3000, 00:10	Meteorologic Model:	Met 1
Compute Time:	30Aug2016, 11:57:36	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

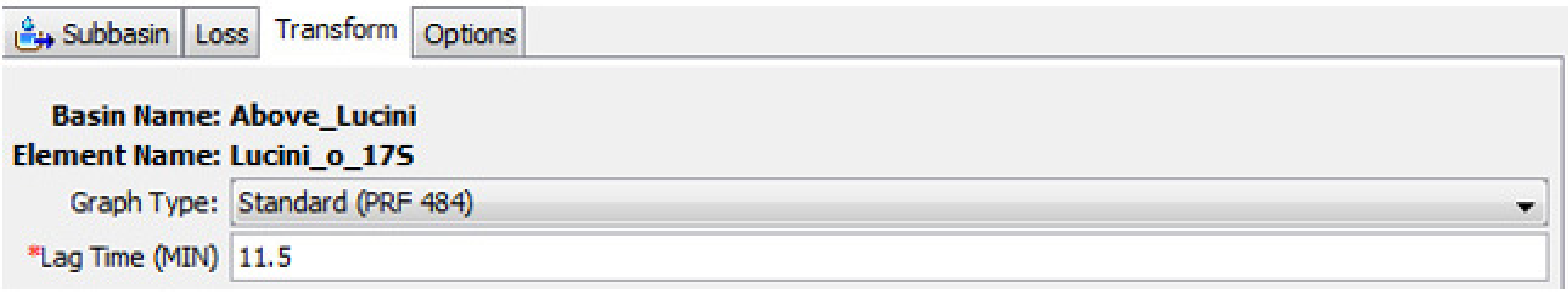
Peak Discharge:	1.17 (CFS)	Date/Time of Peak Discharge:	01Jan3000, 08:06
Precipitation Volume:	3.90 (IN)	Direct Runoff Volume:	1.20 (IN)
Loss Volume:	2.70 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	1.20 (IN)	Discharge Volume:	1.20 (IN)

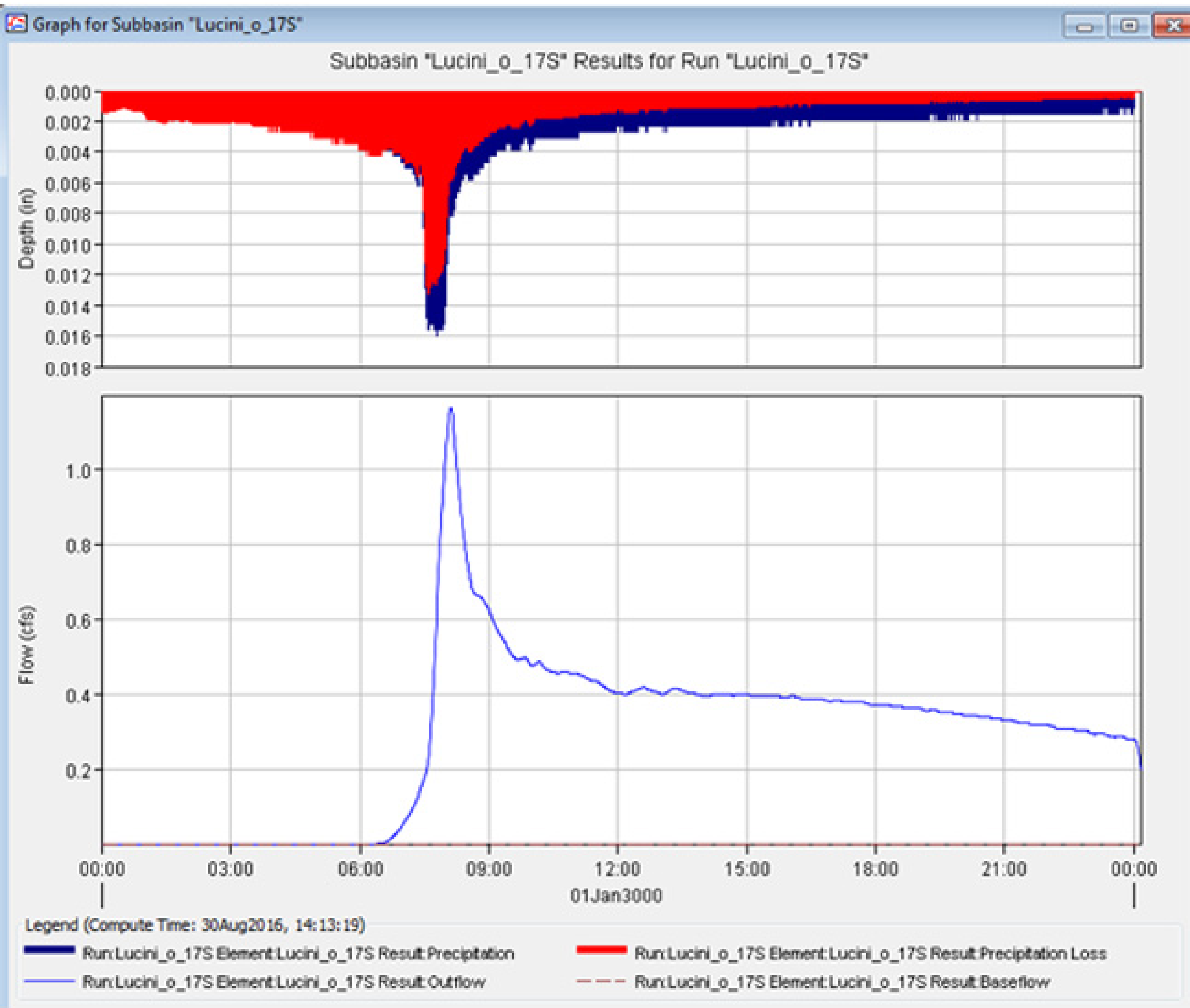
Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini
Element Name: Lucini_o_17S

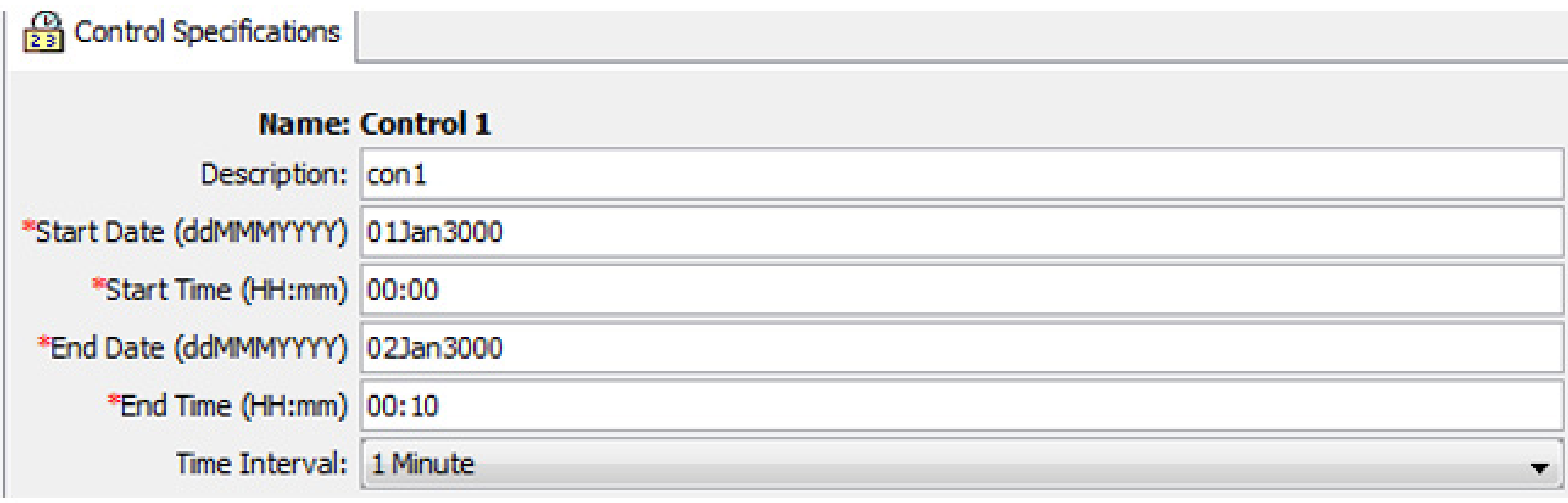
Description:	sub1
Downstream:	--None--
*Area (MI2)	0.009048
Latitude Degrees:	
Latitude Minutes:	
Latitude Seconds:	
Longitude Degrees:	
Longitude Minutes:	
Longitude Seconds:	
Canopy Method:	--None--
Surface Method:	--None--
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	--None--


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini
Element Name: Lucini_o_17S
Initial Abstraction (IN)
*Curve Number: 69
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini
Element Name: Lucini_o_17S
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 11.5


Graph for Subbasin "Lucini_o_17S"
Subbasin "Lucini_o_17S" Results for Run "Lucini_o_17S"
Depth (in)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
Flow (cfs)
1.0
0.8
0.6
0.4
0.2
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan3000
Legend (Compute Time: 30Aug2016, 14:13:19)
Run:Lucini_o_17S Element:Lucini_o_17S Result:Precipitation
Run:Lucini_o_17S Element:Lucini_o_17S Result:Precipitation Loss
Run:Lucini_o_17S Element:Lucini_o_17S Result:Outflow
Run:Lucini_o_17S Element:Lucini_o_17S Result:Baseflow


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini
Element Name: Lucini_o_17S
Observed Flow:
--None--
Observed Stage:
--None--
Observed SWE:
--None--
Elev-Discharge:
--None--
Ref Flow (CFS)
Ref Label:


Control Specifications
Name: Control 1
Description:
con1
*Start Date (ddMMMYYYY)
01Jan3000
*Start Time (HH:mm)
00:00
*End Date (ddMMMYYYY)
02Jan3000
*End Time (HH:mm)
00:10
Time Interval:
1 Minute

Global Summary Results for Run "Lucini_o_17S_base_aa"

Project: BF_o_17S_base_aa   Simulation Run: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 12:30:08   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: (•) IN ( ) AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Lucini_o_17S_base_aa	0.00678	0.89	01Jan3000, 08:05	1.20

Summary Results for Subbasin "Lucini_o_17S_base_aa"

Project: BF_o_17S_base_aa   Simulation Run: Lucini_o_17S_base_aa
Subbasin: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 12:30:08   Control Specifications: Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

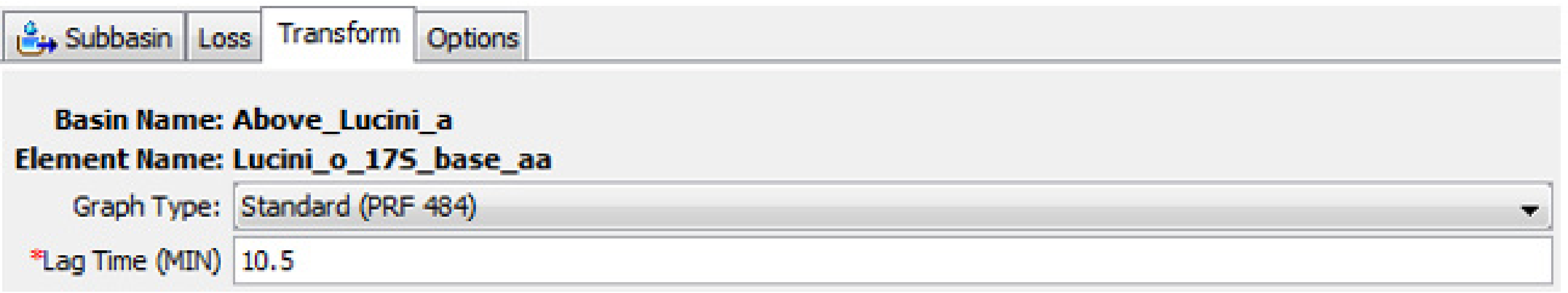
Peak Discharge:	0.89 (CFS)	Date/Time of Peak Discharge:	01Jan3000, 08:05
Precipitation Volume:	3.90 (IN)	Direct Runoff Volume:	1.20 (IN)
Loss Volume:	2.70 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	1.20 (IN)	Discharge Volume:	1.20 (IN)

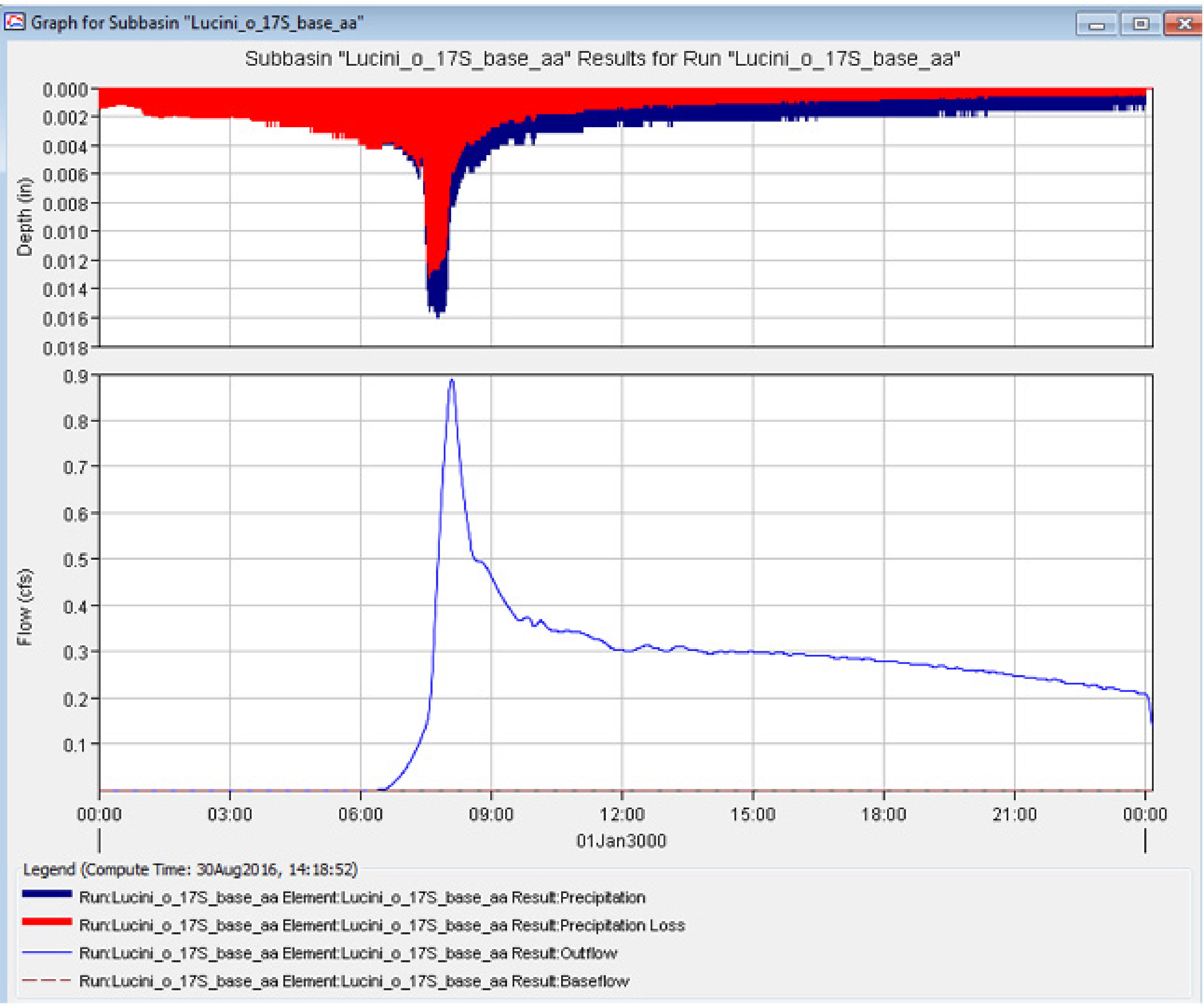
Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa

Description:	sub1
Downstream:	--None--
*Area (MI2)	0.00678
Latitude Degrees:	
Latitude Minutes:	
Latitude Seconds:	
Longitude Degrees:	
Longitude Minutes:	
Longitude Seconds:	
Canopy Method:	--None--
Surface Method:	--None--
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	--None--


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa
Initial Abstraction (IN)
*Curve Number: 69
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 10.5


Graph for Subbasin "Lucini_o_17S_base_aa"
Subbasin "Lucini_o_17S_base_aa" Results for Run "Lucini_o_17S_base_aa"
Depth (in)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
Flow (cfs)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan3000
Legend (Compute Time: 30Aug2016, 14:18:52)
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Precipitation
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Precipitation Loss
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Outflow
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Baseflow

Global Summary Results for Run "Lucini_o_17S_base_aa"

Project: Lucini_o-17S_LU Simulation Run: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00 Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10 Meteorologic Model: Met 1
Compute Time: 30Aug2016, 12:56:51 Control Specifications: Control 1

Show Elements: All Elements Volume Units: (•) IN ( ) AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Lucini_o_17S_base_aa	0.006781	1.71	01Jan3000, 08:04	1.80

Summary Results for Subbasin "Lucini_o_17S_base_aa"

Project: Lucini_o-17S_LU Simulation Run: Lucini_o_17S_base_aa
Subbasin: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00 Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10 Meteorologic Model: Met 1
Compute Time: 30Aug2016, 12:56:51 Control Specifications: Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

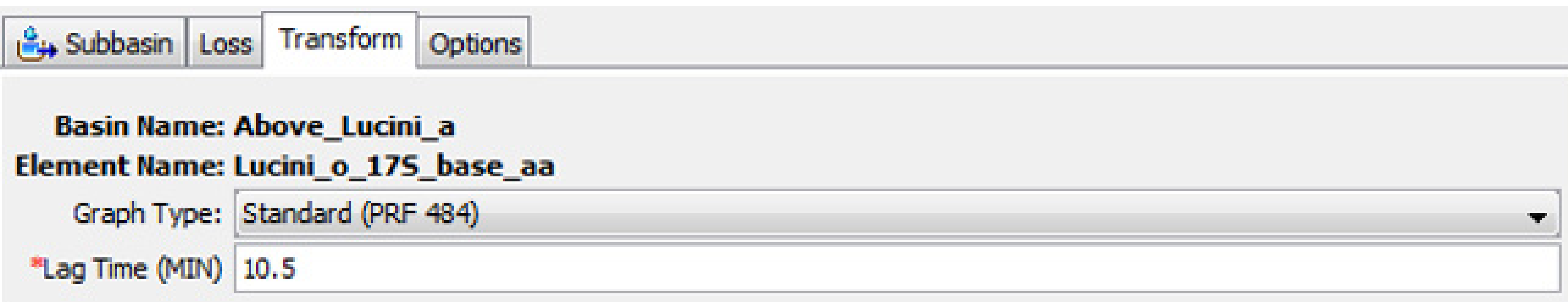
Peak Discharge: 1.71 (CFS) Date/Time of Peak Discharge: 01Jan3000, 08:04
Precipitation Volume: 3.90 (IN) Direct Runoff Volume: 1.80 (IN)
Loss Volume: 2.10 (IN) Baseflow Volume: 0.00 (IN)
Excess Volume: 1.80 (IN) Discharge Volume: 1.80 (IN)

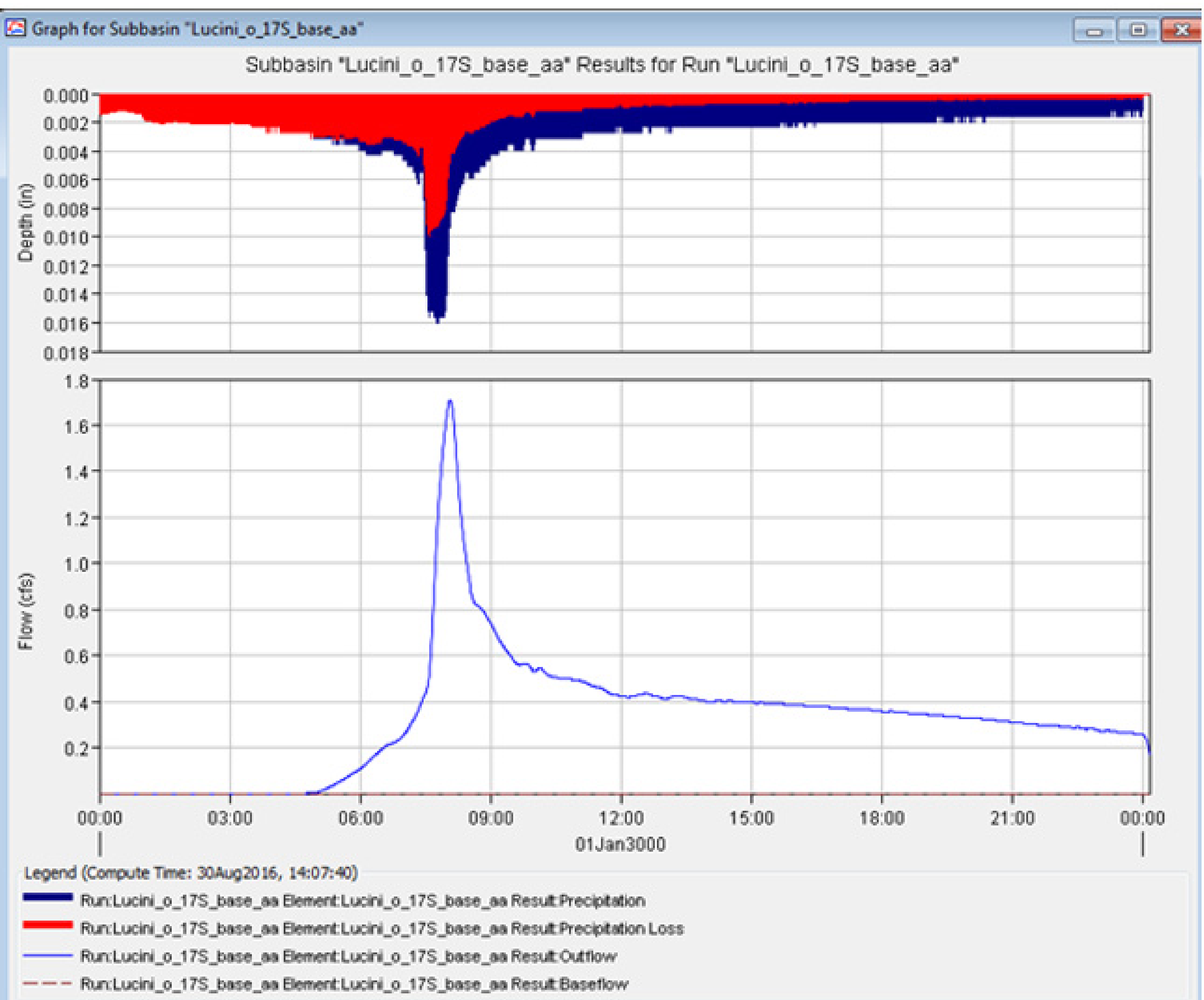
Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa

Description:	sub1
Downstream:	--None--
*Area (MI2)	0.006781
Latitude Degrees:	
Latitude Minutes:	
Latitude Seconds:	
Longitude Degrees:	
Longitude Minutes:	
Longitude Seconds:	
Canopy Method:	--None--
Surface Method:	--None--
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	--None--


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa
Initial Abstraction (IN)
*Curve Number: 77.9
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 10.5


Graph for Subbasin "Lucini_o_17S_base_aa"
Subbasin "Lucini_o_17S_base_aa" Results for Run "Lucini_o_17S_base_aa"
Depth (in)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
Flow (cfs)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan3000
Legend (Compute Time: 30Aug2016, 14:07:40)
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Precipitation
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Precipitation Loss
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Outflow
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Baseflow

Global Summary Results for Run "Lucini_o_17S_base_aa"

Project: Lucini_o_17S_BO Simulation Run: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00 Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10 Meteorologic Model: Met 1
Compute Time: 30Aug2016, 13:38:09 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Lucini_o_17S_base_aa	0.006781	2.85	01Jan3000, 08:02	2.63

Summary Results for Subbasin "Lucini_o_17S_base_aa"

Project: Lucini_o_17S_BO Simulation Run: Lucini_o_17S_base_aa
Subbasin: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00 Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10 Meteorologic Model: Met 1
Compute Time: 30Aug2016, 13:38:09 Control Specifications: Control 1

Volume Units: IN AC-FT

Computed Results

Peak Discharge: 2.85 (CFS) Date/Time of Peak Discharge: 01Jan3000, 08:02
Precipitation Volume: 3.90 (IN) Direct Runoff Volume: 2.63 (IN)
Loss Volume: 1.26 (IN) Baseflow Volume: 0.00 (IN)
Excess Volume: 2.64 (IN) Discharge Volume: 2.63 (IN)

Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa

Description:	sub1
Downstream:	--None--
*Area (MI2)	0.006781
Latitude Degrees:	
Latitude Minutes:	
Latitude Seconds:	
Longitude Degrees:	
Longitude Minutes:	
Longitude Seconds:	
Canopy Method:	--None--
Surface Method:	--None--
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	--None--

Subbasin | **Loss** | Transform | Options

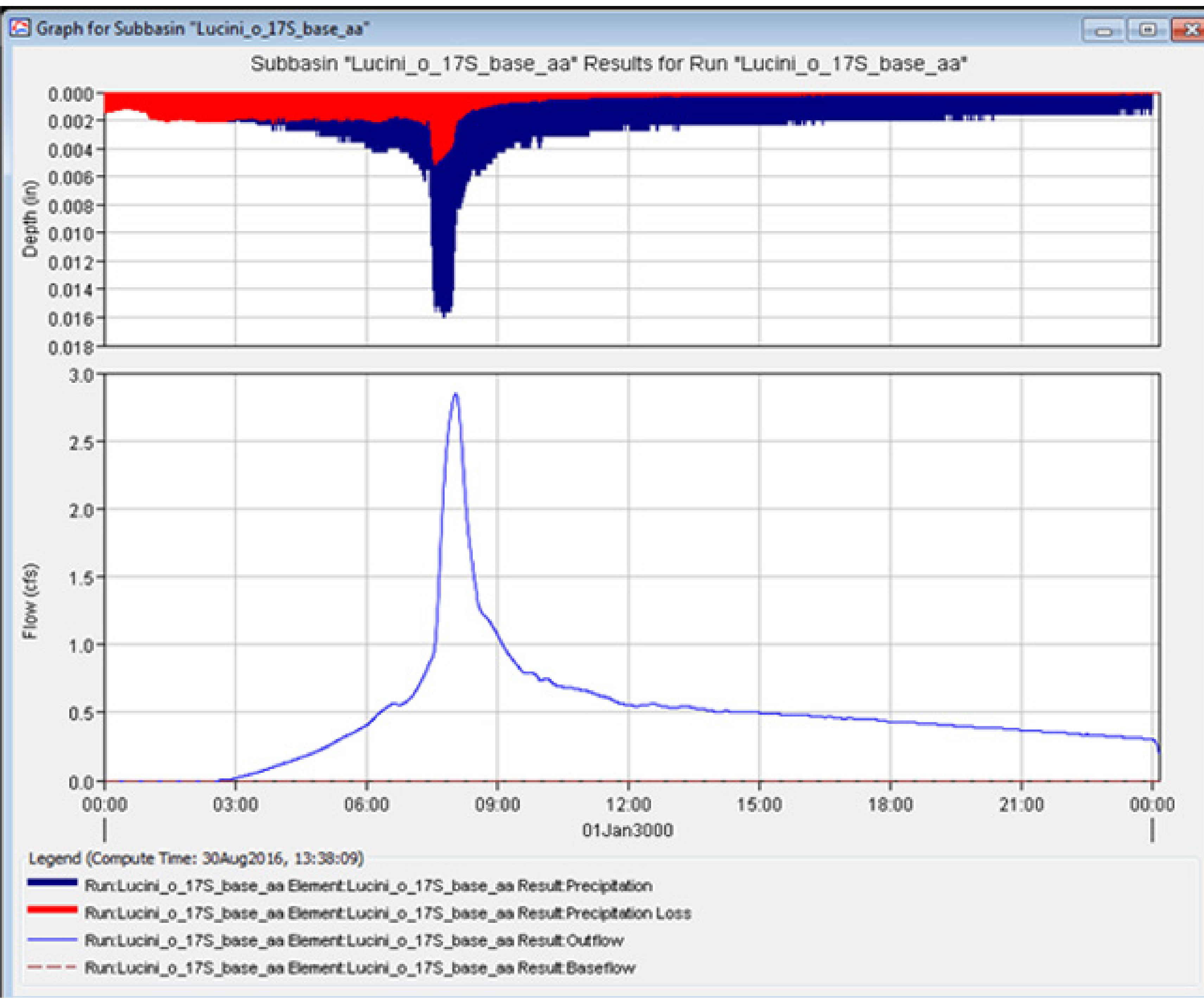
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa

Initial Abstraction (IN)	
*Curve Number:	88
*Impervious (%)	0

Subbasin | Loss | **Transform** | Options

Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa

Graph Type:	Standard (PRF 484)
*Lag Time (MIN)	10.5



Summary for Subcatchment 59S: Pro Aux 5

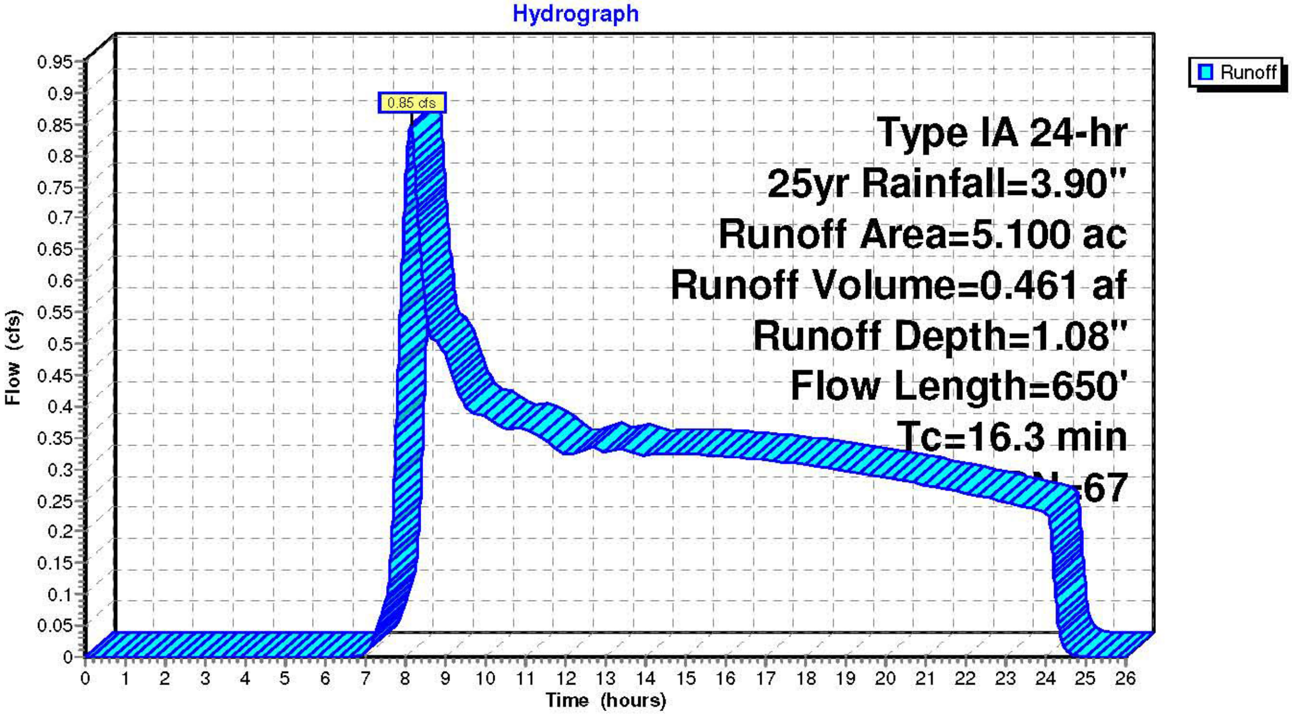
Runoff = 0.85 cfs @ 8.13 hrs, Volume= 0.461 af, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25yr Rainfall=3.90"

Area (ac)	CN	Description
3.800	65	2 acre lots, 12% imp, HSG B
1.300	74	Farmsteads, HSG B
5.100	67	Weighted Average
4.644		91.06% Pervious Area
0.456		8.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0100	0.09		**Sheet Flow, Field** Cultivated: Residue>20% n= 0.170 P2= 2.50"
6.5	500	0.0200	1.27		**Shallow Concentrated Flow, Field** Cultivated Straight Rows Kv= 9.0 fps
0.5	100	0.0400	3.22		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
16.3	650	Total			

Subcatchment 59S: Pro Aux 5



From County Storm Drainage Report for SW Boones Ferry Road (Jan 2013), PDF Page 101 of 152.

Table LU_b. IMPLEMENTED Subbasin Areas with Future Land Use Conditions
Weighted Curve Numbers used in HEC-HMS Hydrologic Modeling for Varying Land Use Cases

Weighted average CN Calculations

Inplemented On-going Land Use (LU)

Area (ac)	CN	Description		
1.9	65	2 acre lot, 12% imp., HSG B		
1.9	92	Urban Districts: Commercial and Business		
1.3	74	Farmsteads, HSG B		LU Case CN
5.1	77.4	Weighted Average	Weighted Average CN	77.4

Implemented, Full Build-out (BO)

Area (ac)	CN	Description		
1.9	85	2 acre lot, 12% imp., HSG B		
1.9	92	Urban Districts: Commercial and Business		
1.3	85	Residential Districts: 1/8 acre		BO Case CN
5.1	87.6	Weighted Average	Weighted Average CN	87.6

Global Summary Results for Run "BF_i_59S"

Project: BF_i_59S Simulation Run: BF_i_59S

Start of Run: 01Jan3000, 00:00 Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10 Meteorologic Model: Met 1
Compute Time: 30Aug2016, 14:53:52 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
BF_i_59s	0.007956	0.85	01Jan3000, 08:06	1.08

Summary Results for Subbasin "BF_i_59s"

Project: BF_i_59S Simulation Run: BF_i_59S
Subbasin: BF_i_59s

Start of Run: 01Jan3000, 00:00 Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10 Meteorologic Model: Met 1
Compute Time: 30Aug2016, 14:53:52 Control Specifications: Control 1

Volume Units: IN AC-FT

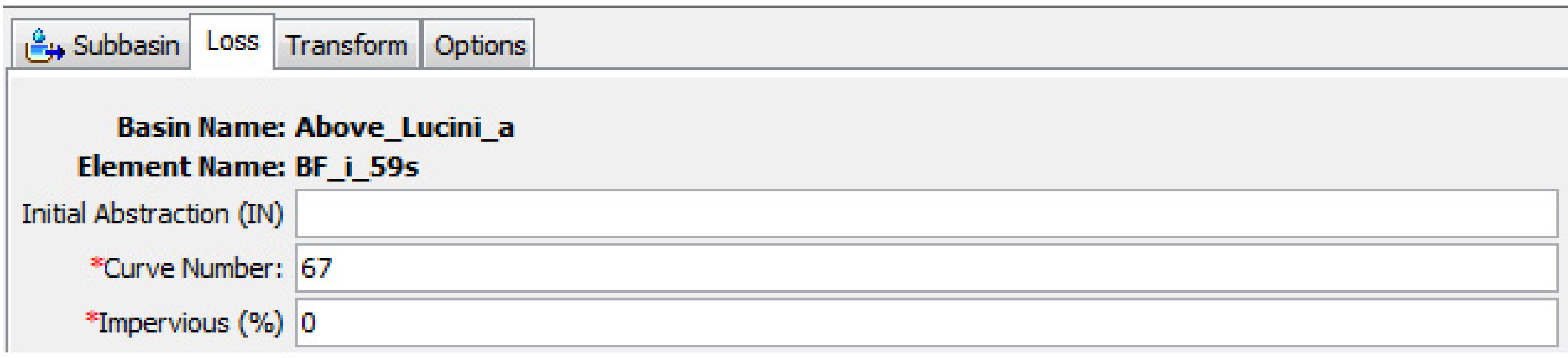
Computed Results

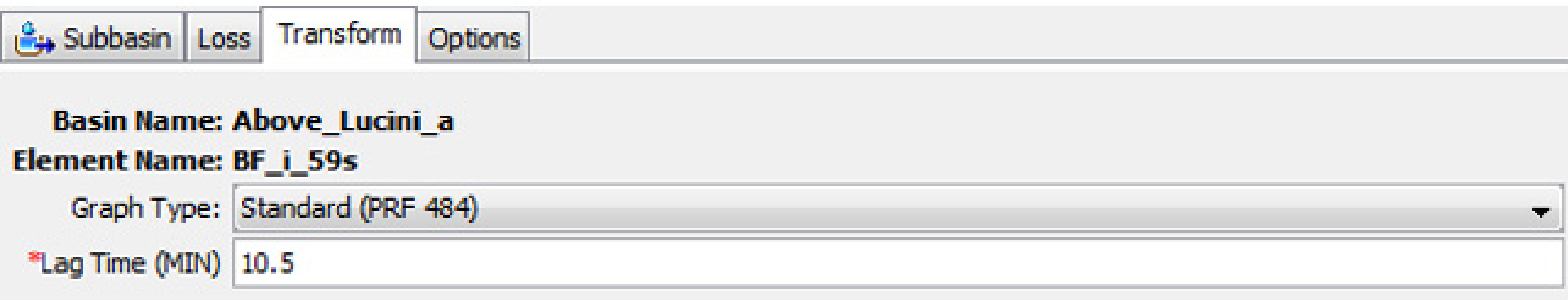
Peak Discharge:	0.85 (CFS)	Date/Time of Peak Discharge:	01Jan3000, 08:06
Precipitation Volume:	3.90 (IN)	Direct Runoff Volume:	1.08 (IN)
Loss Volume:	2.82 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	1.08 (IN)	Discharge Volume:	1.08 (IN)

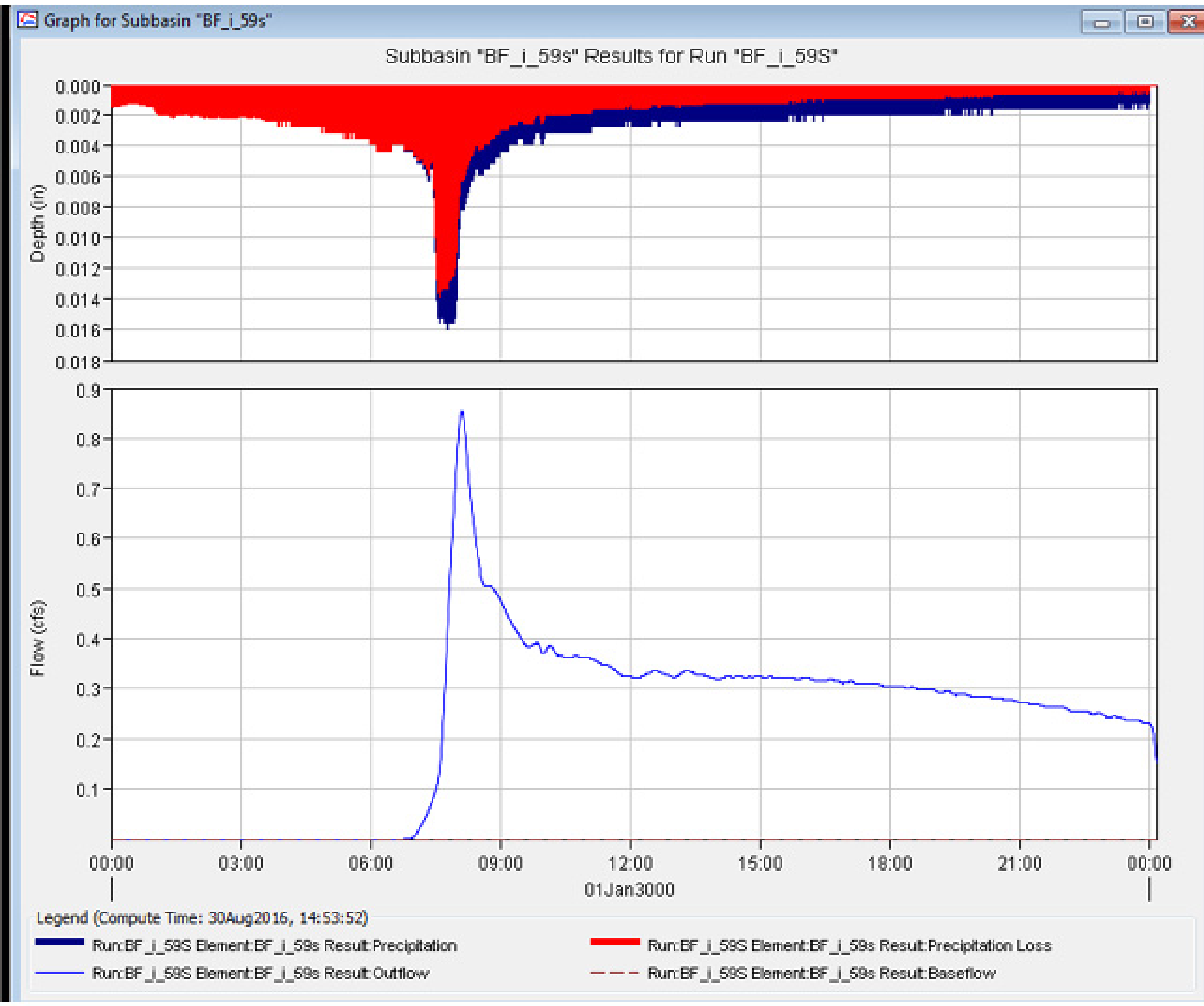
Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: BF_i_59s

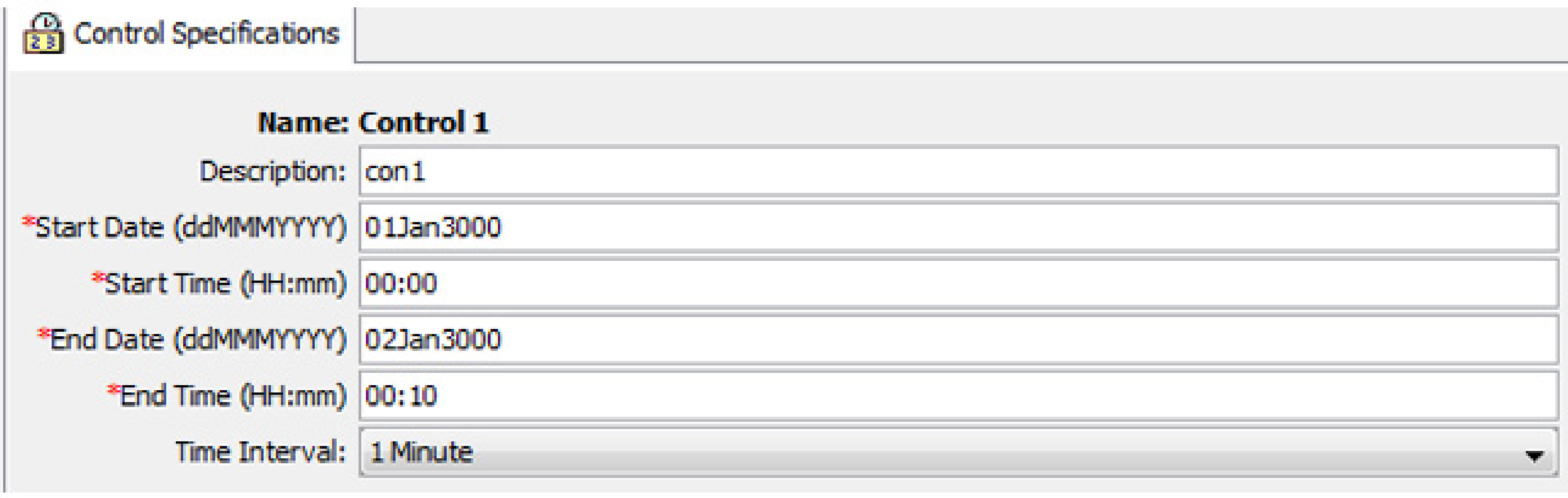
Description:	sub1
Downstream:	--None--
*Area (MI2)	0.007956
Latitude Degrees:	
Latitude Minutes:	
Latitude Seconds:	
Longitude Degrees:	
Longitude Minutes:	
Longitude Seconds:	
Canopy Method:	--None--
Surface Method:	--None--
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	--None--


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s
Initial Abstraction (IN)
*Curve Number: 67
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 10.5


Graph for Subbasin "BF_i_59s"
Subbasin "BF_i_59s" Results for Run "BF_i_59S"
Depth (in)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
Flow (cfs)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan3000
Legend (Compute Time: 30Aug2016, 14:53:52)
Run:BF_i_59S Element:BF_i_59s Result:Precipitation
Run:BF_i_59S Element:BF_i_59s Result:Precipitation Loss
Run:BF_i_59S Element:BF_i_59s Result:Outflow
Run:BF_i_59S Element:BF_i_59s Result:Baseflow


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s
Observed Flow:
--None--
Observed Stage:
--None--
Observed SWE:
--None--
Elev-Discharge:
--None--
Ref Flow (CFS)
Ref Label:


Control Specifications
Name: Control 1
Description:
con1
*Start Date (ddMMMYYYY)
01Jan3000
*Start Time (HH:mm)
00:00
*End Date (ddMMMYYYY)
02Jan3000
*End Time (HH:mm)
00:10
Time Interval:
1 Minute

Global Summary Results for Run "BF_i_59S_base_b"

Project: BF_i_59S_base_b Simulation Run: BF_i_59S_base_b

Start of Run: 01Jan3000, 00:01 Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 12:01 Meteorologic Model: Met 1
Compute Time: 26Aug2016, 10:50:41 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
BF_i_59s_base_b	0.005967	0.64	01Jan3000, 08:07	1.08

Summary Results for Subbasin "BF_i_59s_base_b"

Project: BF_i_59S_base_b Simulation Run: BF_i_59S_base_b
Subbasin: BF_i_59s_base_b

Start of Run: 01Jan3000, 00:01 Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 12:01 Meteorologic Model: Met 1
Compute Time: 30Aug2016, 11:28:16 Control Specifications: Control 1

Volume Units: IN AC-FT

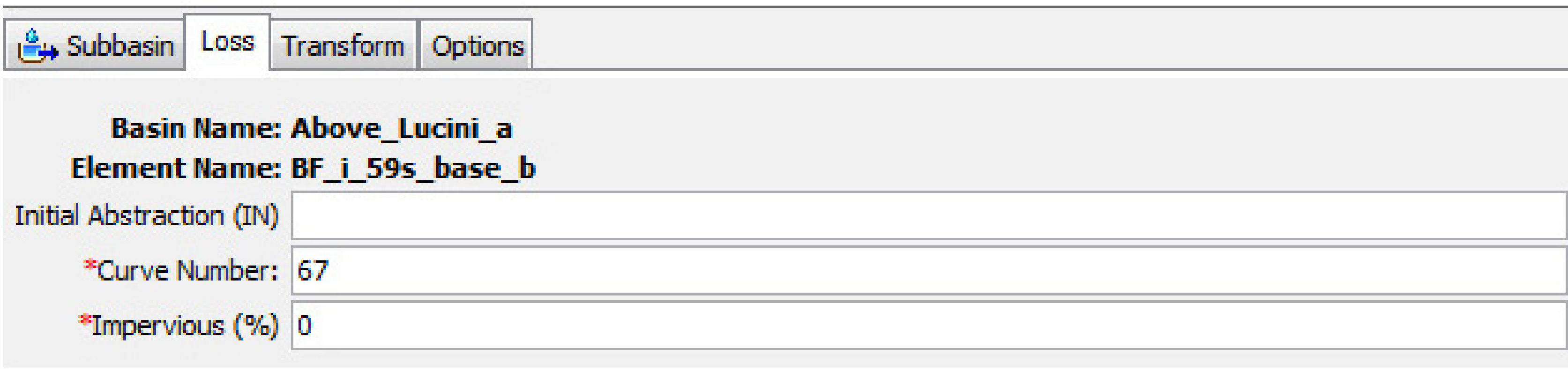
Computed Results

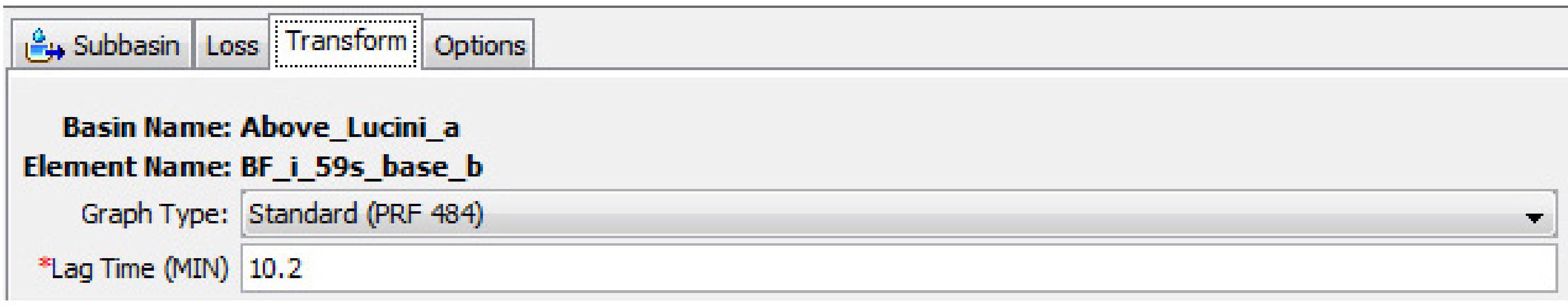
Peak Discharge: 0.64 (CFS) Date/Time of Peak Discharge: 01Jan3000, 08:07
Precipitation Volume: 3.90 (IN) Direct Runoff Volume: 1.08 (IN)
Loss Volume: 2.82 (IN) Baseflow Volume: 0.00 (IN)
Excess Volume: 1.08 (IN) Discharge Volume: 1.08 (IN)

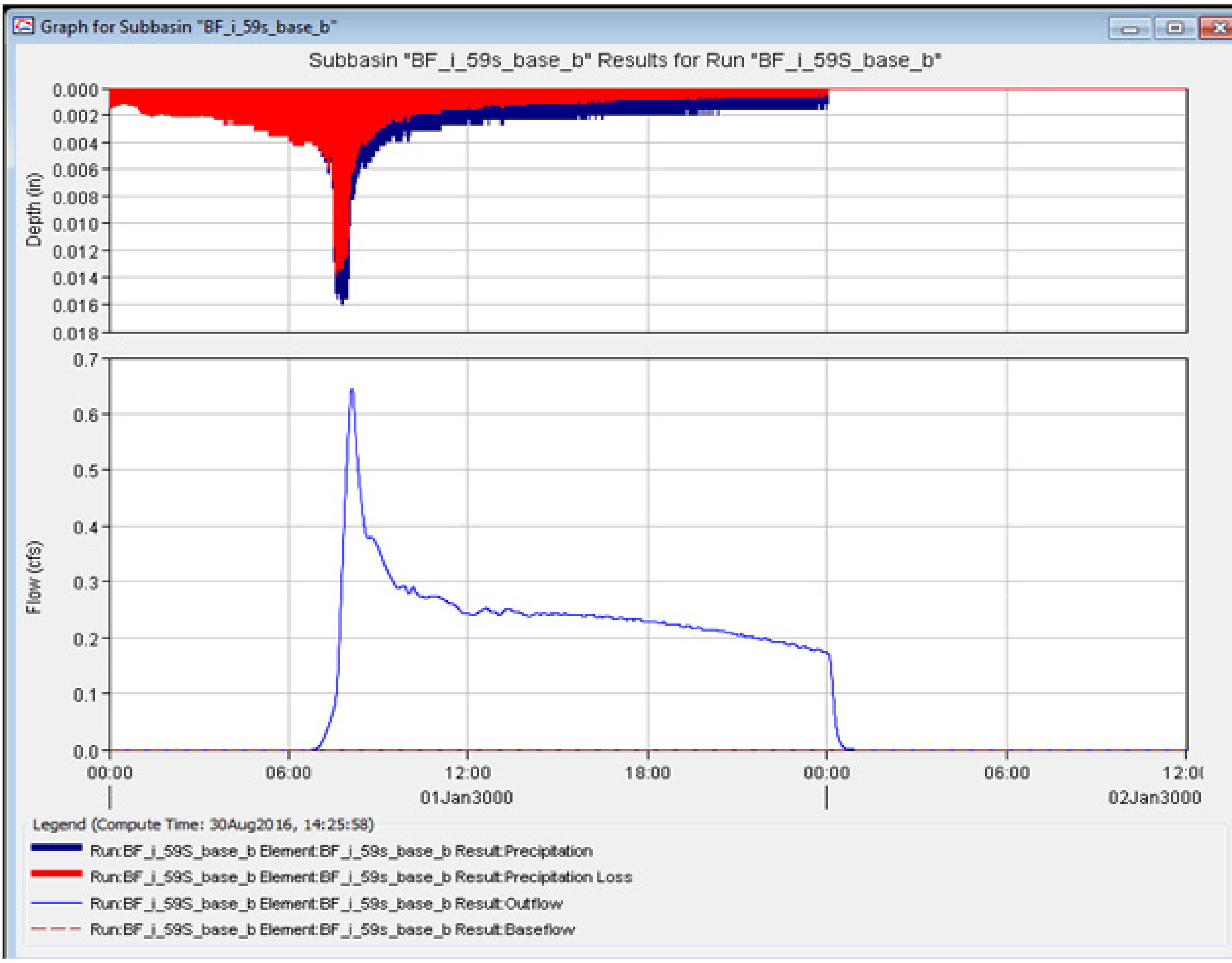
Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: BF_i_59s_base_b

Description: sub1
Downstream: --None--
*Area (MI2) 0.005967
Latitude Degrees:
Latitude Minutes:
Latitude Seconds:
Longitude Degrees:
Longitude Minutes:
Longitude Seconds:
Canopy Method: --None--
Surface Method: --None--
Loss Method: SCS Curve Number
Transform Method: SCS Unit Hydrograph
Baseflow Method: --None--


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s_base_b
Initial Abstraction (IN)
*Curve Number: 67
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s_base_b
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 10.2


Graph for Subbasin "BF_i_59s_base_b"
Subbasin "BF_i_59s_base_b" Results for Run "BF_i_59S_base_b"
Depth (in)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
Flow (cfs)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
00:00
06:00
12:00
18:00
00:00
06:00
01Jan3000
02Jan3000
Legend (Compute Time: 30Aug2016, 14:25:58)
Run:BF_i_59S_base_b Element:BF_i_59s_base_b Result:Precipitation
Run:BF_i_59S_base_b Element:BF_i_59s_base_b Result:Precipitation Loss
Run:BF_i_59S_base_b Element:BF_i_59s_base_b Result:Outflow
Run:BF_i_59S_base_b Element:BF_i_59s_base_b Result:Baseflow

Global Summary Results for Run "BF_i_59S"

Project: BF_i_59S_all_lu   Simulation Run: BF_i_59S

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 15:56:48   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: IN AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
BF_i_59s	0.007956	1.95	01Jan3000, 08:04	1.76

Summary Results for Subbasin "BF_i_59s"

Project: BF_i_59S_all_lu   Simulation Run: BF_i_59S
Subbasin: BF_i_59s

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 15:56:48   Control Specifications: Control 1

Volume Units: IN AC-FT

Computed Results

Peak Discharge: 1.95 (CFS)   Date/Time of Peak Discharge: 01Jan3000, 08:04
Precipitation Volume: 3.90 (IN)   Direct Runoff Volume: 1.76 (IN)
Loss Volume: 2.14 (IN)   Baseflow Volume: 0.00 (IN)
Excess Volume: 1.76 (IN)   Discharge Volume: 1.76 (IN)

Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: BF_i_59s

Description: sub1
Downstream: --None--
*Area (MI2) 0.007956
Latitude Degrees:
Latitude Minutes:
Latitude Seconds:
Longitude Degrees:
Longitude Minutes:
Longitude Seconds:
Canopy Method: --None--
Surface Method: --None--
Loss Method: SCS Curve Number
Transform Method: SCS Unit Hydrograph
Baseflow Method: --None--

Subbasin | Loss | Transform | Options

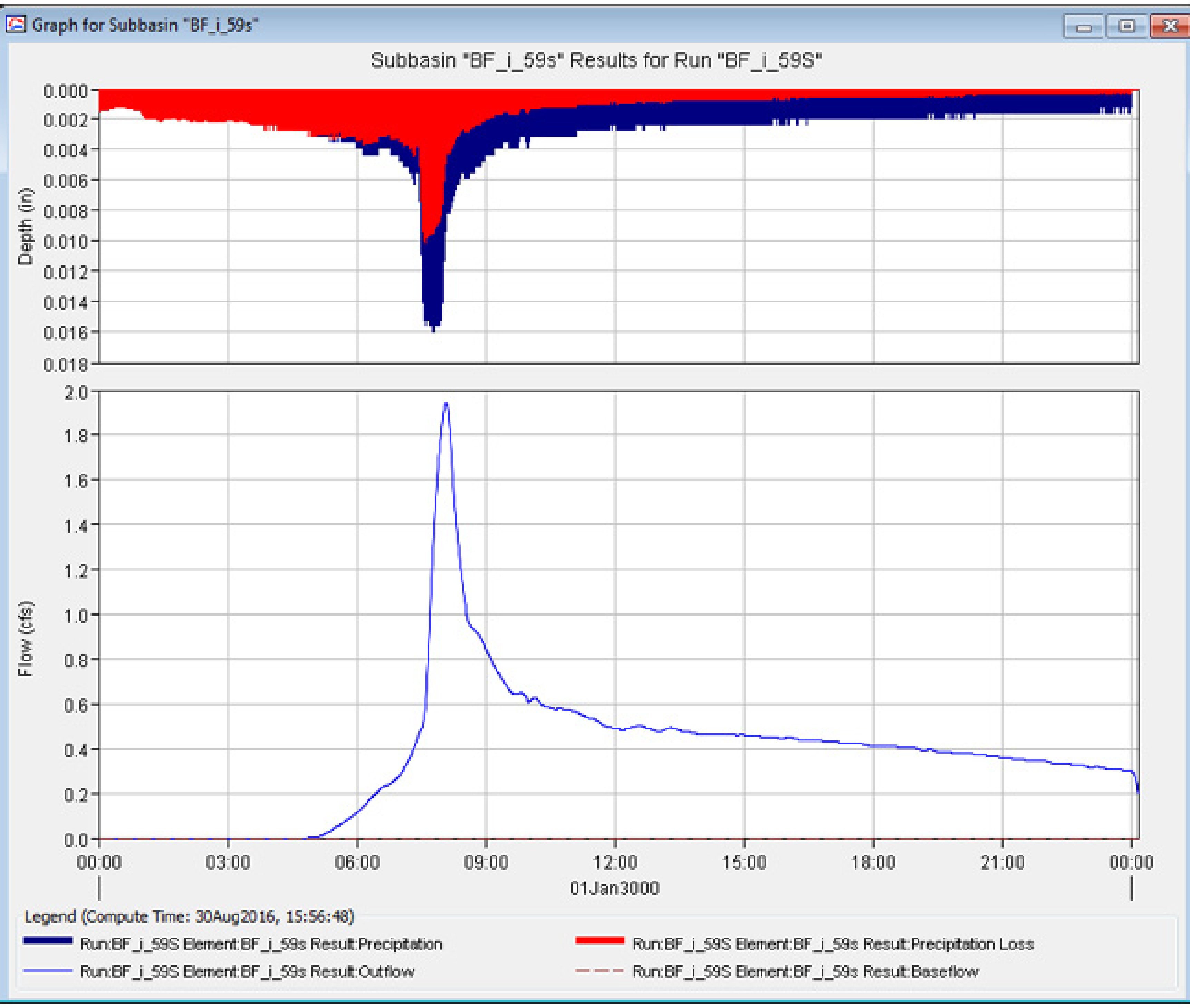
Basin Name: Above_Lucini_a
Element Name: BF_i_59s

Initial Abstraction (IN)	
*Curve Number:	77.4
*Impervious (%)	0

Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: BF_i_59s

Graph Type:	Standard (PRF 484)
*Lag Time (MIN)	10.5



Global Summary Results for Run "BF_i_59S"

Project: BF_i_base_all_bo   Simulation Run: BF_i_59S

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 16:18:37   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: (•) IN ( ) AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
BF_i_59s	0.007956	3.29	01Jan3000, 08:03	2.59

Summary Results for Subbasin "BF_i_59s"

Project: BF_i_base_all_bo   Simulation Run: BF_i_59S
Subbasin: BF_i_59s

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 16:18:37   Control Specifications: Control 1

Volume Units: (•) IN ( ) AC-FT

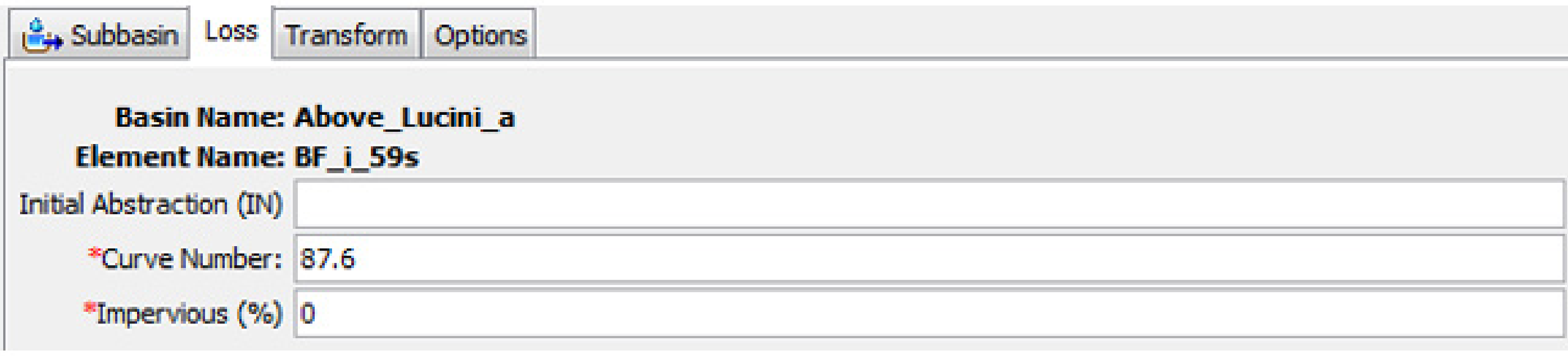
Computed Results

Peak Discharge: 3.29 (CFS)   Date/Time of Peak Discharge: 01Jan3000, 08:03
Precipitation Volume: 3.90 (IN)   Direct Runoff Volume: 2.59 (IN)
Loss Volume: 1.30 (IN)   Baseflow Volume: 0.00 (IN)
Excess Volume: 2.60 (IN)   Discharge Volume: 2.59 (IN)

Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: BF_i_59s

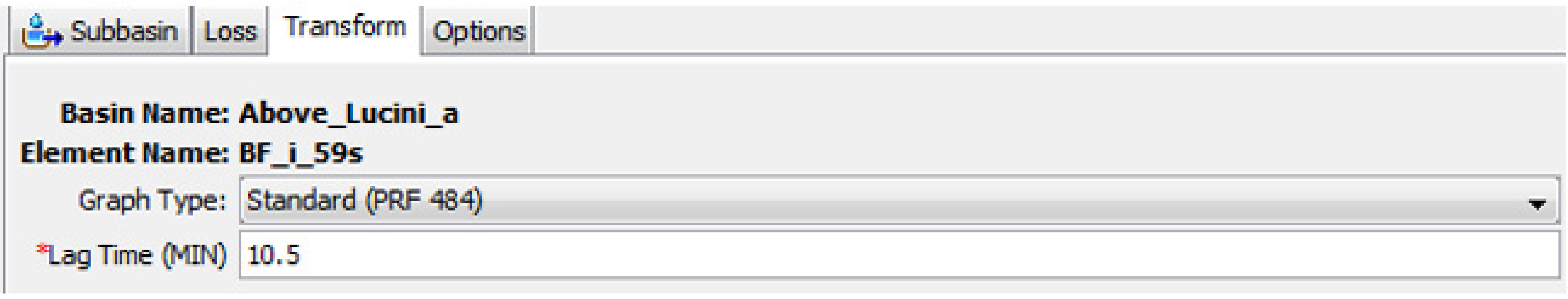
Description: sub1
Downstream: --None--
*Area (MI2) 0.007956
Latitude Degrees:
Latitude Minutes:
Latitude Seconds:
Longitude Degrees:
Longitude Minutes:
Longitude Seconds:
Canopy Method: --None--
Surface Method: --None--
Loss Method: SCS Curve Number
Transform Method: SCS Unit Hydrograph
Baseflow Method: --None--



Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: BF_i_59s

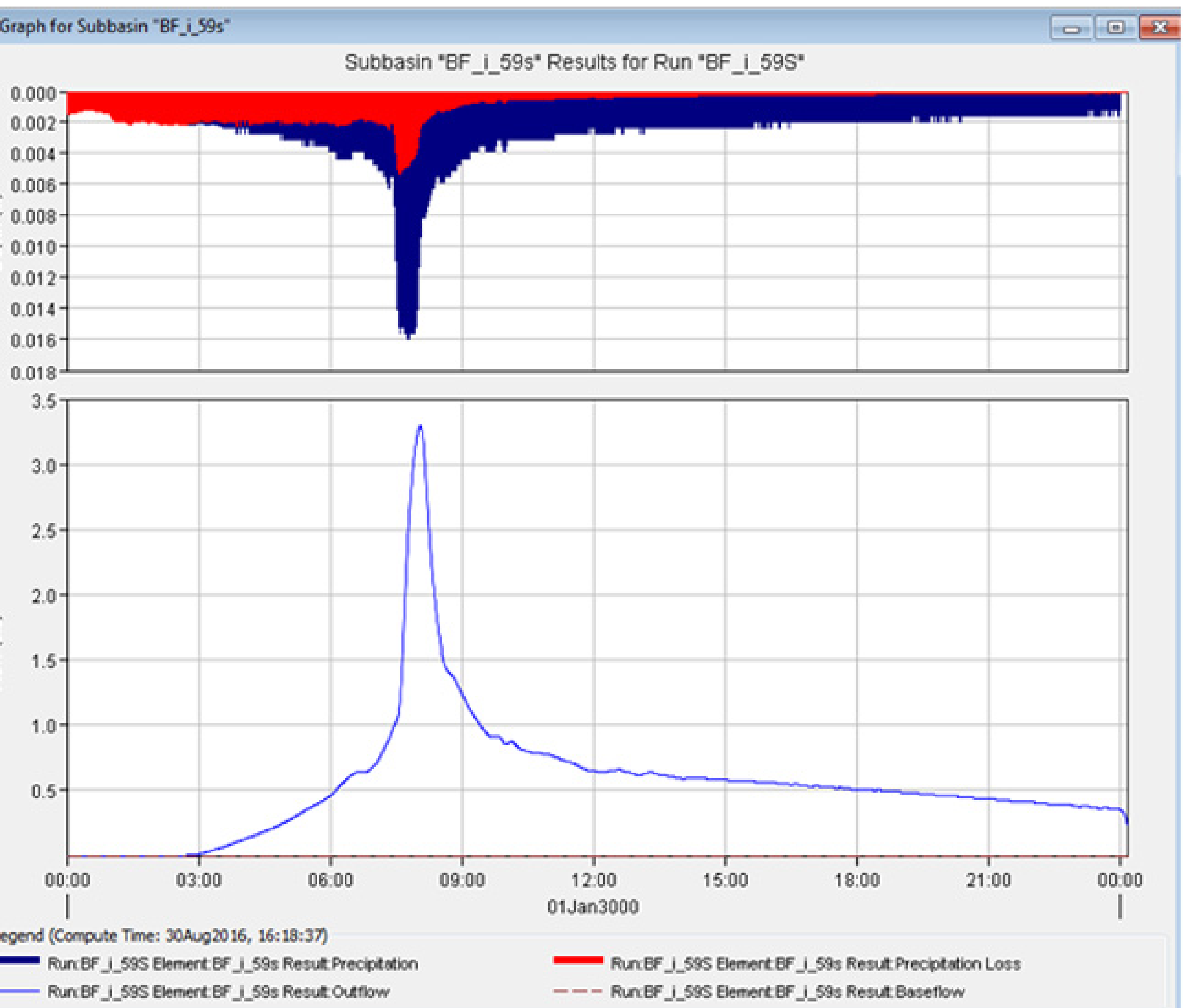
Initial Abstraction (IN)	
*Curve Number:	87.6
*Impervious (%)	0



Subbasin | Loss | Transform | Options

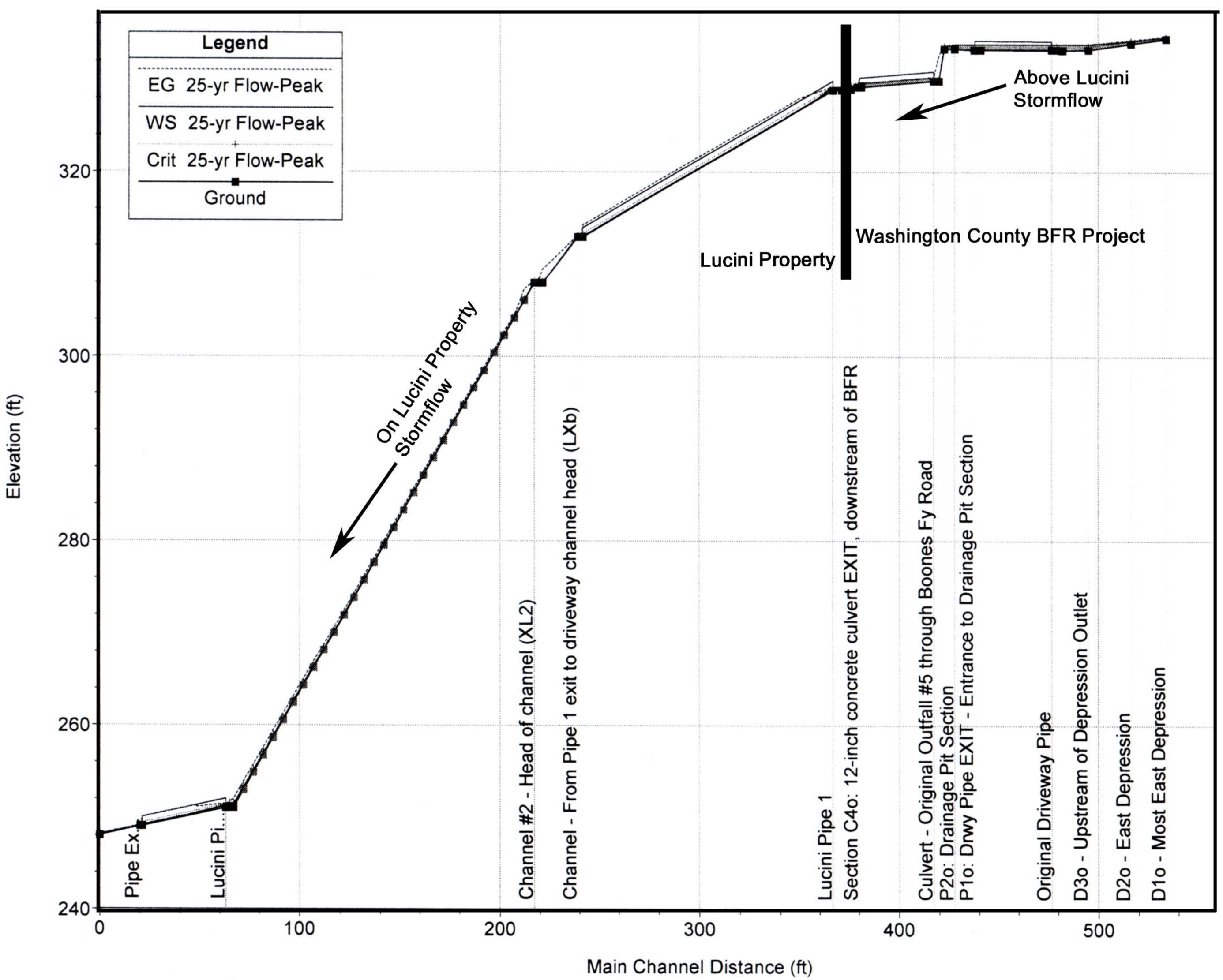
Basin Name: Above_Lucini_a
Element Name: BF_i_59s

Graph Type:	Standard (PRF 484)
*Lag Time (MIN)	10.5



Appendix I

Figure I-1. HEC-RAS Hydraulic Profile of ORIGINAL Pipe and Ditch Conditions at 0.89 cfs
Above and On the Lucini Property



Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: Cor_Orig 0.89cfs River: Above Lucini Reach: o_17S Profile: 25-yr Flow-Peak

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
o_17S	160.2	25-yr Flow-Peak	0.89	334.50	334.76	334.68	334.77	0.011532	0.91	0.98	7.60	0.44
o_17S	142.4	25-yr Flow-Peak	0.89	334.00	334.30	334.30	334.38	0.056691	2.20	0.40	2.67	0.99
o_17S	121.3	25-yr Flow-Peak	0.89	333.30	333.96	333.67	333.97	0.002925	0.81	1.10	3.37	0.25
o_17S	108.4	25-yr Flow-Peak	0.89	333.24	333.93		333.93	0.001875	0.62	1.44	4.44	0.19
o_17S	105.7	25-yr Flow-Peak	0.89	333.30	333.91	333.67	333.93	0.004143	0.92	0.97	3.16	0.29
o_17S	87.4		Culvert									
o_17S	66.4	25-yr Flow-Peak	0.89	333.28	333.92		333.92	0.000206	0.28	3.19	6.83	0.07
o_17S	56.6	25-yr Flow-Peak	0.89	333.40	333.90		333.91	0.006810	1.04	0.85	3.44	0.37
o_17S	51.5	25-yr Flow-Peak	0.89	333.40	333.73	333.73	333.82	0.056356	2.31	0.39	2.31	1.00
o_17S	48.8	25-yr Flow-Peak	0.89	329.94	329.97	330.09	332.61	1.800609	13.05	0.07	2.70	14.46
o_17S	28.6		Culvert									
o_17S	8.8	25-yr Flow-Peak	0.89	329.27	329.68	329.68	329.79	0.057239	2.57	0.35	1.67	1.00
o_17S	4.8	25-yr Flow-Peak	0.89	329.00	329.42	329.37	329.47	0.027824	1.86	0.48	2.30	0.72
o_17S	0.00	25-yr Flow-Peak	0.89	328.92	329.20	329.20	329.28	0.059737	2.16	0.41	2.89	1.01
o_17S	-65		Culvert									
o_17S	-130	25-yr Flow-Peak	0.89	313.00	313.20		313.22	0.009717	1.04	0.85	4.60	0.43
o_17S	-132	25-yr Flow-Peak	0.89	313.00	313.11	313.11	313.17	0.067286	1.91	0.47	4.33	1.03
o_17S	-150	25-yr Flow-Peak	0.89	308.00	308.03	308.11	309.03	7.363283	8.05	0.11	4.08	8.63
o_17S	-152	25-yr Flow-Peak	0.89	308.00	308.22	308.13	308.24	0.009842	1.04	0.85	4.67	0.43
o_17S	-154	25-yr Flow-Peak	0.89	308.00	308.13	308.13	308.19	0.098000	1.97	0.45	3.97	1.03
o_17S	-302	25-yr Flow-Peak	0.89	251.00	251.35	251.48	251.80	0.375062	5.44	0.16	0.95	2.31
o_17S	-304	25-yr Flow-Peak	0.89	251.00	251.48	251.48	251.60	0.062529	2.78	0.32	1.33	1.00
o_17S	-326.5		Culvert									
o_17S	-349	25-yr Flow-Peak	0.89	249.00	249.07	249.07	249.12	0.086052	1.65	0.54	7.66	1.09
o_17S	-369	25-yr Flow-Peak	0.89	248.00	248.17	248.09	248.18	0.010007	0.92	0.97	6.51	0.42

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: Err_Orig 1.17cfs River: Above Lucini Reach: o_17S Profile: 25-yr Flow-Peak

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
o_17S	160.2	25-yr Flow-Peak	1.17	334.50	334.79	334.71	334.80	0.011156	0.96	1.22	8.48	0.44
o_17S	142.4	25-yr Flow-Peak	1.17	334.00	334.34	334.34	334.42	0.054613	2.32	0.50	2.98	0.99
o_17S	121.3	25-yr Flow-Peak	1.17	333.30	334.02	333.72	334.03	0.003334	0.88	1.32	3.89	0.27
o_17S	108.4	25-yr Flow-Peak	1.17	333.24	333.99		333.99	0.002252	0.68	1.72	5.31	0.21
o_17S	105.7	25-yr Flow-Peak	1.17	333.30	333.97	333.72	333.98	0.004599	1.02	1.14	3.43	0.31
o_17S	87.4		Culvert									
o_17S	66.4	25-yr Flow-Peak	1.17	333.28	333.98		333.98	0.000257	0.33	3.57	7.09	0.08
o_17S	56.6	25-yr Flow-Peak	1.17	333.40	333.95		333.97	0.006985	1.13	1.04	3.79	0.38
o_17S	51.5	25-yr Flow-Peak	1.17	333.40	333.77	333.77	333.86	0.054365	2.44	0.48	2.58	1.00
o_17S	48.8	25-yr Flow-Peak	1.17	329.94	329.97	330.12	332.68	1.308928	13.20	0.09	2.70	12.83
o_17S	28.6		Culvert									
o_17S	8.8	25-yr Flow-Peak	1.17	329.27	329.73	329.73	329.85	0.057477	2.76	0.42	1.85	1.01
o_17S	4.8	25-yr Flow-Peak	1.17	329.00	329.36	329.41	329.53	0.105970	3.29	0.36	1.98	1.37
o_17S	0.00	25-yr Flow-Peak	1.17	328.92	329.24	329.24	329.32	0.056489	2.27	0.52	3.24	1.00
o_17S	-65		Culvert									
o_17S	-130	25-yr Flow-Peak	1.17	313.00	313.23		313.25	0.010699	1.19	0.99	4.68	0.45
o_17S	-132	25-yr Flow-Peak	1.17	313.00	313.12	313.13	313.20	0.088360	2.31	0.51	4.36	1.19
o_17S	-150	25-yr Flow-Peak	1.17	308.00	308.05	308.14	308.67	2.370216	6.36	0.18	4.14	5.31
o_17S	-152	25-yr Flow-Peak	1.17	308.00	308.07	308.15	308.45	0.831842	4.94	0.24	3.54	3.37
o_17S	-154	25-yr Flow-Peak	1.17	308.00	308.15	308.15	308.22	0.091385	2.11	0.55	4.16	1.02
o_17S	-302	25-yr Flow-Peak	1.17	251.00	251.38	251.54	251.91	0.374716	5.82	0.20	1.05	2.35
o_17S	-304	25-yr Flow-Peak	1.17	251.00	251.54	251.54	251.67	0.060366	2.93	0.40	1.48	1.00
o_17S	-326.5		Culvert									
o_17S	-349	25-yr Flow-Peak	1.17	249.00	249.09	249.09	249.14	0.070877	1.72	0.68	7.83	1.03
o_17S	-369	25-yr Flow-Peak	1.17	248.00	248.20	248.11	248.21	0.010001	1.01	1.16	6.77	0.43

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: LU_Orig 1.71cfs River: Above Lucini Reach: o_17S Profile: 25-yr Flow-Peak

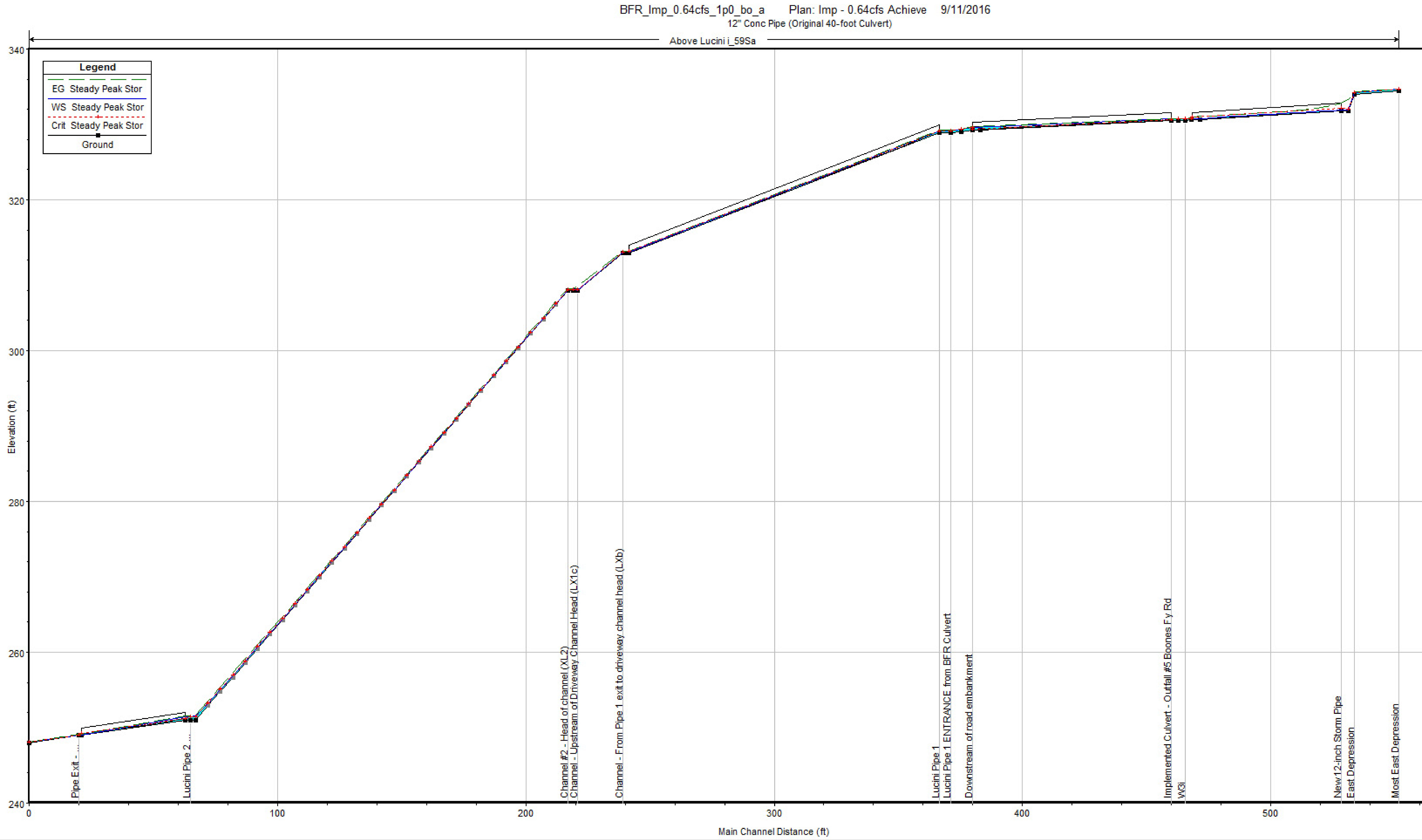
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
o_17S	160.2	25-yr Flow-Peak	1.71	334.50	334.84	334.74	334.85	0.010207	1.02	1.68	9.94	0.44
o_17S	142.4	25-yr Flow-Peak	1.71	334.00	334.39	334.39	334.49	0.054093	2.54	0.67	3.44	1.01
o_17S	121.3	25-yr Flow-Peak	1.71	333.30	334.11	333.79	334.13	0.004242	0.97	1.77	5.54	0.30
o_17S	108.4	25-yr Flow-Peak	1.71	333.24	334.07		334.08	0.002629	0.76	2.24	6.65	0.23
o_17S	105.7	25-yr Flow-Peak	1.71	333.30	334.05	333.79	334.07	0.006123	1.18	1.46	4.45	0.36
o_17S	87.4		Culvert									
o_17S	66.4	25-yr Flow-Peak	1.71	333.28	334.06		334.06	0.000351	0.41	4.18	7.48	0.10
o_17S	56.6	25-yr Flow-Peak	1.71	333.40	334.02		334.05	0.007513	1.28	1.34	4.31	0.40
o_17S	51.5	25-yr Flow-Peak	1.71	333.40	333.83	333.83	333.94	0.051589	2.63	0.65	3.00	0.99
o_17S	48.8	25-yr Flow-Peak	1.71	329.94	329.99	330.17	332.78	0.843351	13.41	0.13	2.70	10.87
o_17S	28.6		Culvert									
o_17S	8.8	25-yr Flow-Peak	1.71	329.27	329.80	329.80	329.94	0.054404	2.97	0.58	2.16	1.01
o_17S	4.8	25-yr Flow-Peak	1.71	329.00	329.41	329.47	329.62	0.113652	3.71	0.46	2.25	1.44
o_17S	0.00	25-yr Flow-Peak	1.71	328.92	329.29	329.29	329.38	0.052889	2.43	0.70	3.78	1.00
o_17S	-65		Culvert									
o_17S	-130	25-yr Flow-Peak	1.71	313.00	313.28		313.31	0.011691	1.40	1.23	4.83	0.49
o_17S	-132	25-yr Flow-Peak	1.71	313.00	313.16	313.17	313.26	0.078067	2.56	0.67	4.47	1.17
o_17S	-150	25-yr Flow-Peak	1.71	308.00	308.05	308.17	309.02	2.947858	7.88	0.22	4.16	6.07
o_17S	-152	25-yr Flow-Peak	1.71	308.00	308.31	308.20	308.33	0.011372	1.34	1.27	5.30	0.48
o_17S	-154	25-yr Flow-Peak	1.71	308.00	308.20	308.20	308.28	0.081682	2.31	0.74	4.49	1.00
o_17S	-302	25-yr Flow-Peak	1.71	251.00	251.44	251.62	252.08	0.375093	6.40	0.27	1.21	2.40
o_17S	-304	25-yr Flow-Peak	1.71	251.00	251.53	251.62	251.83	0.139144	4.41	0.39	1.46	1.51
o_17S	-326.5		Culvert									
o_17S	-349	25-yr Flow-Peak	1.71	249.00	249.12	249.12	249.18	0.061679	1.90	0.90	8.08	1.00
o_17S	-369	25-yr Flow-Peak	1.71	248.00	248.24	248.15	248.26	0.010004	1.15	1.49	7.20	0.45

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: BO_Orig 2.85cfs River: Above Lucini Reach: o_17S Profile: 25-yr Flow-Peak

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
o_17S	160.2	25-yr Flow-Peak	2.85	334.50	334.92	334.80	334.94	0.009158	1.11	2.57	12.28	0.43
o_17S	142.4	25-yr Flow-Peak	2.85	334.00	334.48	334.48	334.60	0.049261	2.79	1.02	4.24	1.00
o_17S	121.3	25-yr Flow-Peak	2.85	333.30	334.25	333.89	334.27	0.004561	1.06	2.70	7.96	0.32
o_17S	108.4	25-yr Flow-Peak	2.85	333.24	334.21		334.22	0.002898	0.87	3.27	8.71	0.25
o_17S	105.7	25-yr Flow-Peak	2.85	333.30	334.18	333.89	334.21	0.007433	1.30	2.19	6.73	0.40
o_17S	87.4		Culvert									
o_17S	66.4	25-yr Flow-Peak	2.85	333.28	334.19		334.20	0.000519	0.55	5.23	8.11	0.12
o_17S	56.6	25-yr Flow-Peak	2.85	333.40	334.14		334.18	0.008075	1.49	1.91	5.15	0.43
o_17S	51.5	25-yr Flow-Peak	2.85	333.40	333.93	333.93	334.06	0.050191	2.96	0.96	3.66	1.01
o_17S	48.8	25-yr Flow-Peak	2.85	329.94	330.02	330.27	332.92	0.469839	13.68	0.21	2.70	8.68
o_17S	28.6		Culvert									
o_17S	8.8	25-yr Flow-Peak	2.85	329.27	329.93	329.93	330.09	0.049951	3.27	0.87	2.66	1.00
o_17S	4.8	25-yr Flow-Peak	2.85	329.00	329.50	329.58	329.77	0.111470	4.18	0.68	2.74	1.48
o_17S	0.00	25-yr Flow-Peak	2.85	328.92	329.38	329.38	329.49	0.049294	2.69	1.06	4.64	0.99
o_17S	-65		Culvert									
o_17S	-130	25-yr Flow-Peak	2.85	313.00	313.36		313.41	0.013243	1.74	1.64	5.08	0.54
o_17S	-132	25-yr Flow-Peak	2.85	313.00	313.23	313.24	313.36	0.064030	2.89	0.98	4.68	1.11
o_17S	-150	25-yr Flow-Peak	2.85	308.00	308.07	308.24	309.65	3.452740	10.07	0.28	4.21	6.85
o_17S	-152	25-yr Flow-Peak	2.85	308.00	308.39	308.27	308.43	0.012447	1.62	1.76	5.95	0.52
o_17S	-154	25-yr Flow-Peak	2.85	308.00	308.27	308.27	308.38	0.076003	2.64	1.08	5.02	1.01
o_17S	-302	25-yr Flow-Peak	2.85	251.00	251.53	251.77	252.36	0.375560	7.28	0.39	1.47	2.48
o_17S	-304	25-yr Flow-Peak	2.85	251.00	251.74	251.77	251.96	0.064544	3.76	0.76	2.04	1.09
o_17S	-326.5		Culvert									
o_17S	-349	25-yr Flow-Peak	2.85	249.00	249.17	249.17	249.24	0.055550	2.21	1.29	8.50	1.00
o_17S	-369	25-yr Flow-Peak	2.85	248.00	248.33	248.20	248.35	0.010003	1.35	2.10	7.93	0.46


BFR_Imp_0.64cfs_1p0_bo_a Plan: Imp - 0.64cfs Achieve 9/11/2016
12" Conc Pipe (Original 40-foot Culvert)
Above Lucini i_59Sa
Legend
EG Steady Peak Stor
WS Steady Peak Stor
Crit Steady Peak Stor
Ground
Elevation (ft)
Main Channel Distance (ft)
Pipe Exit - ...
Lucini Pipe 2 ...
Channel #2 - Head of channel (XL2)
Channel - Upstream of Driveway Channel Head (LX1c)
Channel - From Pipe 1 exit to driveway channel head (LXb)
Lucini Pipe 1
Lucini Pipe 1 ENTRANCE from BFR Culvert
Downstream of road embankment
Implemented Culvert - Outfall #5 Boones Fy Rd
W3i
New 12-inch Storm Pipe
East Depression
Most East Depression

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: IMP 0.64cfs Ach River: Above Lucini Reach: i_59Sa Profile: Steady Peak Stor

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
i_59Sa	175.3	Steady Peak Stor	0.64	334.50	334.73	334.66	334.74	0.011869	0.84	0.76	6.68	0.44
i_59Sa	157.5	Steady Peak Stor	0.64	334.00	334.27	334.27	334.33	0.059196	2.06	0.31	2.34	0.99
i_59Sa	154.8	Steady Peak Stor	0.64	331.80	331.87	332.03	333.24	0.289235	9.41	0.07	1.00	6.36
i_59Sa	120		Culvert									
i_59Sa	94.5	Steady Peak Stor	0.64	330.60	330.75	330.75	330.82	0.005384	2.15	0.30	2.00	0.98
i_59Sa	91.8	Steady Peak Stor	0.64	330.55	330.75	330.70	330.79	0.002079	1.59	0.40	2.00	0.62
i_59Sa	89.1	Steady Peak Stor	0.64	330.55	330.70	330.70	330.77	0.005576	2.17	0.29	2.00	1.00
i_59Sa	49		Culvert									
i_59Sa	9.1	Steady Peak Stor	0.64	329.27	329.63	329.63	329.72	0.059744	2.40	0.27	1.47	0.99
i_59Sa	4.3	Steady Peak Stor	0.64	329.00	329.36	329.32	329.41	0.030271	1.77	0.36	2.00	0.73
i_59Sa	0.00	Steady Peak Stor	0.64	328.92	329.17	329.17	329.23	0.060142	2.00	0.32	2.55	0.99
i_59Sa	-65		Culvert									
i_59Sa	-130	Steady Peak Stor	0.64	313.00	313.18		313.19	0.006681	0.82	0.78	4.55	0.35
i_59Sa	-132	Steady Peak Stor	0.64	313.00	313.09	313.09	313.14	0.078006	1.77	0.36	4.26	1.07
i_59Sa	-150	Steady Peak Stor	0.64	308.00	308.03	308.10	308.55	3.864839	5.82	0.11	4.08	6.25
i_59Sa	-152	Steady Peak Stor	0.64	308.00	308.20	308.11	308.21	0.006900	0.83	0.77	4.53	0.36
i_59Sa	-154	Steady Peak Stor	0.64	308.00	308.11	308.11	308.16	0.098240	1.76	0.36	3.80	1.00
i_59Sa	-302	Steady Peak Stor	0.64	251.00	251.59	251.42	251.62	0.010996	1.33	0.48	1.63	0.43
i_59Sa	-304	Steady Peak Stor	0.64	251.00	251.42	251.42	251.53	0.065191	2.60	0.25	1.16	0.99
i_59Sa	-326.5		Culvert									
i_59Sa	-349	Steady Peak Stor	0.64	249.00	249.06	249.06	249.09	0.075315	1.40	0.46	7.57	1.00
i_59Sa	-369	Steady Peak Stor	0.64	248.00	248.14	248.07	248.15	0.010003	0.82	0.78	6.25	0.41

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: IMP 0.85cfs River: Above Lucini Reach: i_59Sa Profile: Steady Peak Stor

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
i_59Sa	175.3	Steady Peak Stor	0.85	334.50	334.76	334.68	334.77	0.010967	0.88	0.97	7.54	0.43
i_59Sa	157.5	Steady Peak Stor	0.85	334.00	334.30	334.30	334.37	0.059039	2.21	0.39	2.60	1.01
i_59Sa	154.8	Steady Peak Stor	0.85	331.80	331.89	332.08	333.29	0.215416	9.51	0.09	1.00	5.60
i_59Sa	120		Culvert									
i_59Sa	94.5	Steady Peak Stor	0.85	330.60	330.78	330.78	330.87	0.004860	2.31	0.37	2.00	0.95
i_59Sa	91.8	Steady Peak Stor	0.85	330.55	330.79	330.73	330.84	0.002135	1.77	0.48	2.00	0.64
i_59Sa	89.1	Steady Peak Stor	0.85	330.55	330.73	330.73	330.82	0.005435	2.39	0.36	2.00	1.00
i_59Sa	49		Culvert									
i_59Sa	9.1	Steady Peak Stor	0.85	329.27	329.68	329.68	329.78	0.057611	2.55	0.33	1.64	1.00
i_59Sa	4.3	Steady Peak Stor	0.85	329.00	329.33	329.36	329.46	0.093919	2.90	0.29	1.80	1.26
i_59Sa	0.00	Steady Peak Stor	0.85	328.92	329.21	329.21	329.27	0.044824	1.92	0.44	3.00	0.88
i_59Sa	-65		Culvert									
i_59Sa	-130	Steady Peak Stor	0.85	313.00	313.21		313.22	0.007623	0.95	0.90	4.62	0.38
i_59Sa	-132	Steady Peak Stor	0.85	313.00	313.11	313.11	313.16	0.075371	1.95	0.44	4.31	1.08
i_59Sa	-150	Steady Peak Stor	0.85	308.00	308.03	308.11	308.67	3.636185	6.39	0.13	4.10	6.25
i_59Sa	-152	Steady Peak Stor	0.85	308.00	308.05	308.13	308.51	1.668853	5.47	0.16	3.37	4.49
i_59Sa	-154	Steady Peak Stor	0.85	308.00	308.13	308.13	308.18	0.092597	1.91	0.45	3.96	1.00
i_59Sa	-302	Steady Peak Stor	0.85	251.00	251.66	251.47	251.69	0.010986	1.43	0.59	1.81	0.44
i_59Sa	-304	Steady Peak Stor	0.85	251.00	251.47	251.47	251.59	0.065314	2.79	0.30	1.29	1.01
i_59Sa	-326.5		Culvert									
i_59Sa	-349	Steady Peak Stor	0.85	249.00	249.07	249.07	249.11	0.084703	1.61	0.53	7.65	1.08
i_59Sa	-369	Steady Peak Stor	0.85	248.00	248.16	248.10	248.18	0.010013	0.91	0.94	6.47	0.42

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: IMP 1.95cfs River: Above Lucini Reach: i_59Sa Profile: Steady Peak Stor

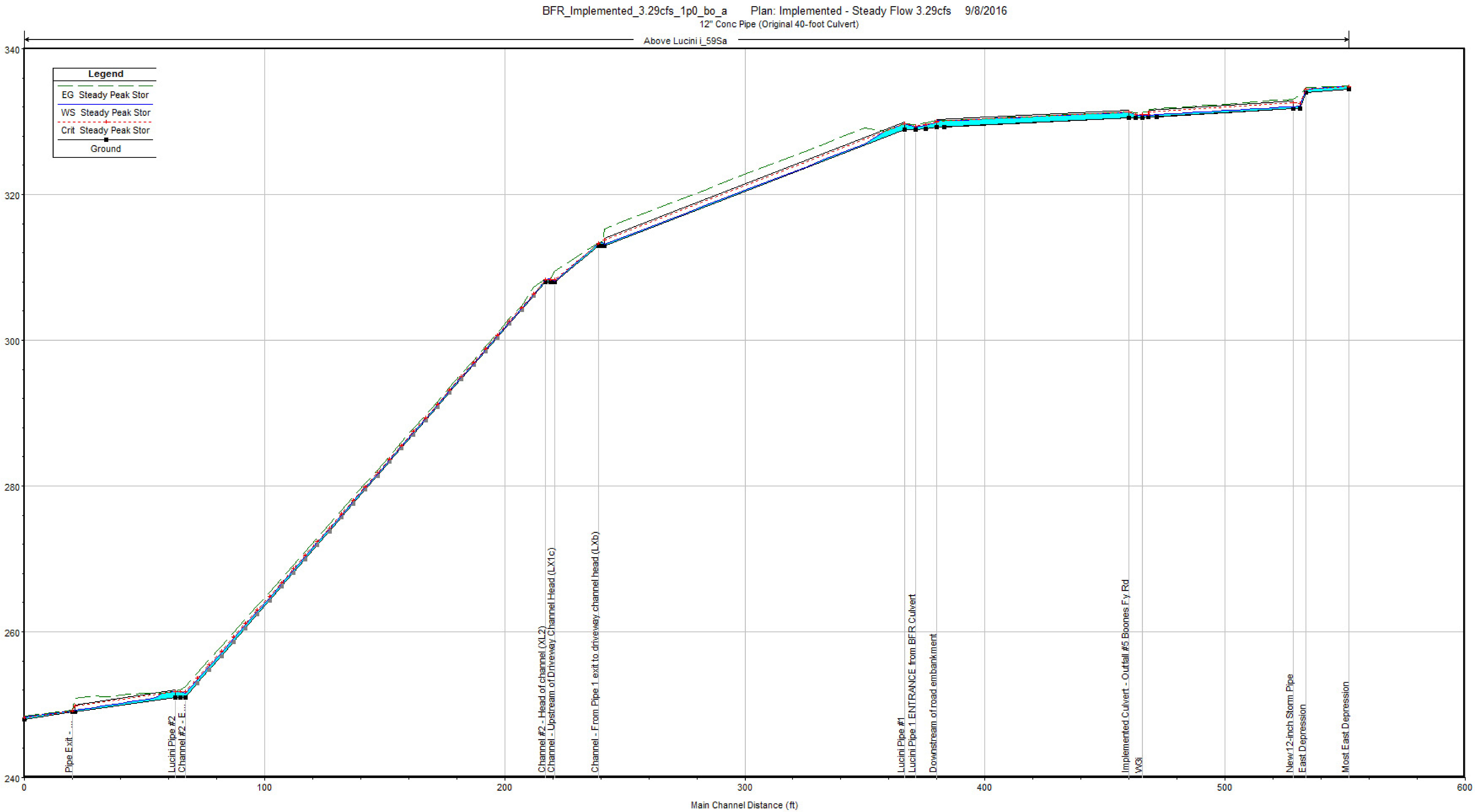
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
i_59Sa	175.3	Steady Peak Stor	1.95	334.50	334.85	334.75	334.87	0.010335	1.06	1.84	10.41	0.44
i_59Sa	157.5	Steady Peak Stor	1.95	334.00	334.41	334.41	334.52	0.051301	2.58	0.76	3.65	1.00
i_59Sa	154.8	Steady Peak Stor	1.95	331.80	332.00	332.29	333.49	0.098788	9.80	0.20	1.00	3.87
i_59Sa	120		Culvert									
i_59Sa	94.5	Steady Peak Stor	1.95	330.60	330.94	330.91	331.07	0.003944	2.87	0.68	2.00	0.87
i_59Sa	91.8	Steady Peak Stor	1.95	330.55	330.96	330.86	331.05	0.002295	2.40	0.81	2.00	0.66
i_59Sa	89.1	Steady Peak Stor	1.95	330.55	330.86	330.86	331.01	0.005240	3.16	0.62	2.00	1.00
i_59Sa	49		Culvert									
i_59Sa	9.1	Steady Peak Stor	1.95	329.27	329.84	329.84	329.98	0.052108	3.02	0.65	2.29	1.00
i_59Sa	4.3	Steady Peak Stor	1.95	329.00	329.44	329.50	329.65	0.105045	3.72	0.52	2.40	1.40
i_59Sa	0.00	Steady Peak Stor	1.95	328.92	329.31	329.31	329.41	0.053963	2.54	0.77	3.96	1.01
i_59Sa	-65		Culvert									
i_59Sa	-130	Steady Peak Stor	1.95	313.00	313.32		313.35	0.009015	1.34	1.45	4.97	0.44
i_59Sa	-132	Steady Peak Stor	1.95	313.00	313.18	313.19	313.28	0.061572	2.49	0.78	4.55	1.06
i_59Sa	-150	Steady Peak Stor	1.95	308.00	308.06	308.19	309.21	3.355479	8.62	0.23	4.17	6.52
i_59Sa	-152	Steady Peak Stor	1.95	308.00	308.36	308.21	308.38	0.008566	1.27	1.54	5.66	0.43
i_59Sa	-154	Steady Peak Stor	1.95	308.00	308.21	308.21	308.30	0.080059	2.39	0.82	4.61	1.00
i_59Sa	-302	Steady Peak Stor	1.95	251.00	251.46	251.66	252.14	0.375315	6.62	0.29	1.27	2.42
i_59Sa	-304	Steady Peak Stor	1.95	251.00	251.66	251.66	251.82	0.058525	3.30	0.59	1.80	1.01
i_59Sa	-326.5		Culvert									
i_59Sa	-349	Steady Peak Stor	1.95	249.00	249.13	249.13	249.19	0.064594	2.02	0.97	8.15	1.03
i_59Sa	-369	Steady Peak Stor	1.95	248.00	248.26	248.16	248.29	0.010003	1.20	1.63	7.37	0.45

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: IMP 3.29cfs River: Above Lucini Reach: i_59Sa Profile: Steady Peak Stor

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
i_59Sa	175.3	Steady Peak Stor	3.29	334.50	334.94	334.82	334.96	0.009048	1.15	2.87	12.99	0.43
i_59Sa	157.5	Steady Peak Stor	3.29	334.00	334.51	334.51	334.64	0.049598	2.90	1.13	4.47	1.01
i_59Sa	154.8	Steady Peak Stor	3.29	331.80	332.13	332.49	333.66	0.064421	9.91	0.33	1.00	3.03
i_59Sa	120		Culvert									
i_59Sa	94.5	Steady Peak Stor	3.29	330.60	330.90	331.04	331.37	0.016296	5.49	0.60	2.00	1.77
i_59Sa	91.8	Steady Peak Stor	3.29	330.55	330.85	330.99	331.32	0.016296	5.49	0.60	2.00	1.77
i_59Sa	89.1	Steady Peak Stor	3.29	330.55	330.90	330.99	331.24	0.010077	4.68	0.70	2.00	1.39
i_59Sa	49		Culvert									
i_59Sa	9.1	Steady Peak Stor	3.29	329.27	329.96	329.96	330.14	0.050085	3.39	0.97	2.80	1.01
i_59Sa	4.3	Steady Peak Stor	3.29	329.00	329.53	329.61	329.81	0.102500	4.20	0.78	2.93	1.43
i_59Sa	0.00	Steady Peak Stor	3.29	328.92	329.30	329.40	329.60	0.164469	4.39	0.75	3.91	1.77
i_59Sa	-65		Culvert									
i_59Sa	-130	Steady Peak Stor	3.29	313.00	313.43		313.47	0.009499	1.63	2.02	5.30	0.47
i_59Sa	-132	Steady Peak Stor	3.29	313.00	313.26	313.27	313.39	0.057058	2.94	1.12	4.77	1.07
i_59Sa	-150	Steady Peak Stor	3.29	308.00	308.08	308.27	309.51	2.468790	9.60	0.34	4.25	5.96
i_59Sa	-152	Steady Peak Stor	3.29	308.00	308.46	308.29	308.50	0.009105	1.51	2.18	6.46	0.46
i_59Sa	-154	Steady Peak Stor	3.29	308.00	308.29	308.29	308.41	0.073053	2.73	1.21	5.21	1.00
i_59Sa	-302	Steady Peak Stor	3.29	251.00	251.56	251.81	252.44	0.373059	7.52	0.44	1.55	2.50
i_59Sa	-304	Steady Peak Stor	3.29	251.00	251.81	251.81	252.02	0.054487	3.66	0.90	2.22	1.01
i_59Sa	-326.5		Culvert									
i_59Sa	-349	Steady Peak Stor	3.29	249.00	249.18	249.18	249.27	0.056065	2.33	1.41	8.63	1.01
i_59Sa	-369	Steady Peak Stor	3.29	248.00	248.35	248.22	248.38	0.010012	1.42	2.32	8.17	0.47


BFR_Implemented_3.29cfs_1p0_bo_a Plan: Implemented - Steady Flow 3.29cfs 9/8/2016
12" Conc Pipe (Original 40-foot Culvert)
Above Lucini i_59Sa
Legend
EG Steady Peak Stor
WS Steady Peak Stor
Crit Steady Peak Stor
Ground
340
320
300
280
260
240
0
100
200
300
400
500
600
Main Channel Distance (ft)
Pipe Exit - ...
Lucini Pipe #2
Channel #2 - E...
Channel #2 - Head of channel (XL2)
Channel - Upstream of Driveway Channel Head (LX1c)
Channel - From Pipe 1 exit to driveway channel head (LXb)
Lucini Pipe #1
Lucini Pipe 1 ENTRANCE from BFR Culvert
Downstream of road embankment
Implemented Culvert - Outfall #5 Boones Fy Rd
W3i
New 12-inch Storm Pipe
East Depression
Most East Depression

LEA Comments
On the Draft Tualatin Stormwater Master Plan
(Dated April 2019)

Prepared for
John and Grace Lucini
23677 SW Boones Ferry Road
Tualatin, Oregon
97140

Prepared by
Dave LaLiberte
Principal Engineer
Liberte Environmental Associates, Inc.
Wilsonville, Oregon

LEA

December 14, 2020

Draft Comments on the Tualatin Stormwater Master Plan (Draft, April 2019)

Due December 15, 2020, by Dave LaLiberte, P.E., Liberte Environmental Associates (LEA)

Summary Comments

These comments are based on the Draft Tualatin Stormwater Master Plan (SWMP) dated April 2019. Comments highlight issues in the Plan concerning Southwest Boones Ferry Road (BFR) south of Norwood Road, referred to as "BFR south".

Significant problems in the Plan for the BFR south area are: lack of identified stormwater facilities[1] omission of hydrologic and hydraulic modeling analysis[2], potential for mis-application of design alternatives[3], absence of stormwater problem acknowledgement and evaluation[4], no assessment of stormflows on steep slopes[5], effect of stormflows on the Basalt Creek Concept Plan are neglected[6], no existing and future development stormwater flows are compared[7], protection of natural resources is unclear[8], no designation of Capital Improvement Projects (CIPs[9]) in the BFR south area, and other Plan related problems.

Supplement documents collected by Liberte Environmental Associates (LEA) for these comments are identified as:

Supplement A - LEA Request for Tualatin SWMP Appendices

Supplement B - *Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property* (LEA, November 2016).
This report is included in two parts: Supplement B Part 1 (Report) and Part 2 (Appendices) under separate cover because of their size.

Supplement C –David M. LaLiberte, P.E., Cumuli Vitae (CV)

David M. LaLiberte, P.E., Civil and Environmental Engineer licensed in the State of Oregon, has compiled these comments under contract with John and Grace Lucini (see Comment LEA2 below). Dave has over 30 years of experience in stormwater, water quality and design solution analysis. His education and experience are attached as Supplement C – Cumuli Vitae (CV).

[1] See Specific Comment LEA6.

[2] See Specific Comment LEA5.

[3] See Specific Comment LEA9.

[4] See Specific Comments LEA9, 11 and 14 as they pertain to the SWMP Table 3-1 and Figure 7-1.

[5] See Specific Comments LEA5, 7 and 8.

[6] See Specific Comments LEA6, 7, 8, 12 and 15.

[7] See Specific Comment LEA5.

[8] See Specific Comment LEA6.

[9] See Specific Comment LEA4, 9, 10 and 11.

Specific Comments

Comment LEA1. Many of the questions raised in these Tualatin SWMP comments focus on the area along BFR south. The BFR south area is shown within the city limits in all of the corresponding master plan figures. That is: Figures ES-1, 2-2 through 2-6 and 7-1.

Comment LEA2. Many of these comments refer to *Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property* (LEA, November 2016), contracted by John and Grace Lucini, 23677 SW Boones Ferry Road, Washington County, Oregon, Tualatin, Oregon, 97140. This report is referred to as the “Stormflow Analysis” and is attached to these comments as Supplement B Part 1 (Report) and Part 2 (Appendices).

Comment LEA3. The Tualatin SWMP Appendices were obtained (Dec 10, 2020) from the City of Tualatin as part of this comment period ending December 15, 2020. A description of the SWMP Appendix request is contained in LEA Supplement A.

Comment LEA4. Some of the comments reference procedures in other areas of Tualatin. For example, Project Opportunity Area 6 – Alsea, aka Capital Improvement Project #17 (CIP17), calls for infiltration/retention that could be erroneously applied to the BFR south area. These procedures will potentially be applied to the hydrologic and hydraulic modeling in BFR south, and possibly any resulting CIP and stormwater design considerations.

Comment LEA5. The Tualatin SWMP does not include any hydrologic or hydraulic (H/H) modeling for stormwater flows in BFR south. The SWMP must include H/H modeling of the BFR south and affected areas such as the Basalt Creek corridor. Stormwater piping, channels, inlets, outfalls and other stormwater related facilities exist in BFR south (see LEA Supplement B Part 2: Appendices B through E) but are undocumented and un-analyzed in the SWMP. A perusal of the Tualatin SWMP Appendices A through C demonstrates that engineering data and analyses have all been omitted for the BFR south area. The SWMP must include stormwater facilities in Figure 2-6 – Stormwater System Overview for the BFR south and affected areas such as the Basalt Creek corridor. Comparison existing and developed future stormwater flow conditions are not performed. Evaluation of stormflows on hazardous steep slopes is omitted. Assessment of downstream conveyances below Tualatin outfalls is not conducted for the BFR south impacted areas.

Comment LEA6. The Tualatin SWMP does not include any wetlands in BFR south although they do exist. The SWMP Figure 2-5 - Stream Ownership omits the majority of stormwater impacted wetlands in Tualatin. Metro’s Title 13 – Nature in Neighborhoods is intended to protect natural resources in urban areas but none of these opportunities are identified in the Plan for BFR south. The SWMP calls for protecting natural resources in subsections 1.1 Stormwater Master Plan Objectives and 2.2 Future Planning Areas. None of these opportunities are evaluated in the Plan for BFR south especially for the Basalt Creek Concept Plan area.

Comment LEA7. SWMP Figure 2-3 - Topography and Soils map contains too many TEXT overlays in the vicinity of Boones Ferry Road South of Norwood Road and the Lucini Property.

The sensitive steep slope topography in this vicinity can't be read. The "Boones Ferry" and "Basalt Creek" labels need to be moved from this visually important area of this map.

Comment LEA8. SWMP Table 2-1 (Page 2-3) in combination with Figure 2-3 - Topography and Soils suggests that infiltration is not a likely future runoff design solution in the BFR south. This is particularly important since this area is perched above steep slopes draining to Basalt Creek. This area is also above drinking water wells in the area including the Lucini property.

Comment LEA9. When the SWMP Appendix A - CIP Fact Sheets documentation is accessed for the Siuslaw Water Quality Retrofit, which includes the Alsea Road area (CIP17), there is no mention of infiltration in the design. But Table 3-1, Opportunity Area 6, aka CIP17, plainly refers to infiltration. The potential application of infiltration at the CIP17 site is of concern because it is inappropriate based on poorly draining soils (see next comment). As it relates to the BFR south area, applying the same inappropriate infiltration design approach will potentially cause significant problems (see next comment).

Comment LEA10. The BFR south area needs to exclude infiltration facilities as an alternative to reducing surface flow. Figure 7-1 (Page 3-2) does not show any CIP in the vicinity of BFR south although potential problems exist (see LEA Supplement B Part 2: Appendix A.2).

Comment LEA11. SWMP Figure 7-1 does show the location of CIP17, which is additionally described in Table 3-1 - City of Tualatin Stormwater Project Opportunities Number 6 as Alsea/BF Rd and 99th/Siuslaw Greenway. This CIP17 would drain to Hedges Creek and is comprised of "C" type soils as identified by Hydrologic Soil Group (see Section 2.4 -Soils, Table 3-1 and Figure 2-3). "C" type soils poorly drain and do not support functional infiltration facilities. The concern is that the "C" type soils above the Lucini property may be subjected to the same contradictory conclusion as the CIP17 site. This problem of misapplying design solutions may also exist for other conditions because BFR south has not been evaluated by Tualatin for hydrology and hydraulics as well as CIP.

Comment LEA12. SWMP Figure 2-6 - Stormwater System Overview omits the stormwater inlets, piping and other stormwater facilities in and around BFR south. The Stormwater Outfalls to the Basalt Creek Management Area and Greenhill Lane are not indicated (see LEA Supplement B Part 2: Appendix A.2). Downstream channels below the outfalls are not shown.

Comment LEA13. The SWMP Section 9 has incomplete References to Clean Water Services (CWS). The CWS document date and title are not current. For consistence in citing standards, the CWS reference must read "Design and Construction Standards" dated December 2019.

Comment LEA14. Nowhere in the Tualatin SWMP is a Stormwater Field Monitoring or Sampling program identified or proposed. This is despite the fact that Table 3-1 indicates numerous flooding and water quality problems resulting from stormwater flows. Table ES-1 – Capital Project Summary is being proposed without monitoring and sampling program basis.

Comment LEA15. There is no assessment of peak and average stormflows on the steep slopes, which constitute the west flank of the BFR south area. These Tualatin stormflows discharge to the Basalt Creek Concept Plan area and their existence is not established in the SWMP. Stormflows on these steep slopes have excessive peak and average flow velocities, which cause erosion (see Supplement B Part 1 Analysis Report Section 4. Stormflow Hydraulics and Part 2 Appendices A2 and I).

Comment LEA16. The Tualatin SWMP makes no provisions for temporary stormwater storage and discharge facilities when phasing-in large developments such as the Root property in BFR south. The concern is that arbitrary storage and discharge locations could occur in the interim, before the final stormwater facility is operable. It needs to be specified in the Tualatin SWMP that new construction developments must use stormwater facilities and outfalls consistent only with its final specifications and drawings.

Supplements

Supplements Contents

Supplement A

LEA Request for Tualatin SWMP Appendices

Subject:
Re: Review of Draft Tualatin SWMP by LEA
From:
Dave LaLiberte <dave@ee83.com>
Date:
12/10/2020 10:33 AM
To:
Hayden Ausland <hausland@tualatin.gov>
CC:
"grluci@gmail.com" <grluci@gmail.com>

Thanks Hayden.

The files downloaded just fine.

Dave

On 12/10/2020 10:05 AM, Hayden Ausland wrote:
> Good morning Dave,
>
> Due to large files sizes, I've had to upload the appendices to an online file sharing system. The appendices come in two separate files and I'm hoping both hyperlinks below will work for you. Please let me know if you have any issues or problems with accessing these files.
>
> - Appendices A-D: https://cityoftualatin-my.sharepoint.com/:b:/g/personal/hausland_tualatin_gov/EYCg3fA-dVpMrk_014xs9KwB0o-idA1Eo1MdnnKw6fufZw?e=u0CnNH
>
> - Appendices E-I: https://cityoftualatin-my.sharepoint.com/:b:/g/personal/hausland_tualatin_gov/ESQumWDmfCdGrAIq_nTWEgQBNGIFcmZuGrb670B-KzxMow?e=jwjpn9
>
> Regards,
>
> Hayden Ausland, EIT, CPSWQ
> Engineering Associate - Water Quality
> City of Tualatin
> P 503.691.3037 | C 971.978.8217
>
> -----Original Message-----
> From: Dave LaLiberte <dave@ee83.com>
> Sent: Thursday, December 10, 2020 8:55 AM
> To: Hayden Ausland <hausland@tualatin.gov>
> Subject: Review of Draft Tualatin SWMP by LEA
>
> Hi Hayden,
>
> I am an Engineer working with John and Grace Lucini reviewing the Draft Tualatin Stormwater Master Plan (April 2019). I need to obtain the Appendices that are referenced in the report but not included by the City in the report. These are:
>

> Appendix A: CIP Fact Sheets
>
....
> A-1
> Appendix B: Data Compilation and Preliminary Stormwater Project Development (TM1) ... B-1 Appendix C: Hydrology and Hydraulic Modeling Methods and Results (TM2)
> C-1
> Appendix D: Nyberg Creek Flood Reduction Modeling (TM3) .... D-1 Appendix E: Capital Project Modeling Results...
> E-1
> Appendix F: Stream Assessment (TM4)
>
....
> F-1
> Appendix G: CIP Detailed Cost Estimates
....
> G-1
> Appendix H: Staffing Analysis
>
....
> H-1
> Appendix I: Clean Water Services Review Comments
.... I-1
>
> Please let me know at your earliest convenience when I may receive these documents for my review.
>
> Thanks,
> David (Dave) LaLiberte, P.E.
> LIberte Environmental Associates, Inc. (LEA) WIlsonville, Oregon
> 503.582.1558
>

Supplement B: Part 1 – Analysis Report

Included under separate cover because of size.

Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property (LEA, November 2016)

Contracted by John and Grace Lucini, 23677 SW Boones Ferry Road, Washington County, Oregon, Tualatin, Oregon, 97140.
This report is referred to as the "Stormflow Analysis" throughout these comments.

Supplement B: Part 2 – Rpt Appendices

Included under separate cover because of size.

Appendices - *Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property* (LEA, November 2016)

Supplement C

CV for David M. LaLiberte, P.E.

David M. LaLiberte, P.E.
Principal Engineer

Summary:

Mr. LaLiberte's qualifications comprise over 30 years of experience in surface water quality analysis and evaluation, hydrology and hydraulics, stormwater system analysis, biological criteria for water and sediments, environmental quality control, sewage and industrial pollution abatement, effluent treatment alternatives and design, discharge requirements for NPDES wastewater and stormwater permits, mixing zone assessment, water intake and thermal discharges and environmental design. He has managed and performed on many environmental project teams assisting state and federal agencies, as well as municipal and industrial facilities, and non-governmental organizations in Oregon, California, Washington, Alaska and throughout the USA.

Education:	M.S., Civil Engineering, Portland State University, 1990 B.S., Civil Engineering, Portland State University, 1988
Registration:	Professional Engineer, Oregon (Civil and Environmental)

Liberte Environmental Associates, Inc. Experience:

Water Quality Evaluation of the Stormwater Management Plan (SWMP) Proposed for The Dalles, Oregon Wal-Mart Super Center for Karl Anuta, Attorney representing the plaintiff Citizens for Responsible Development in The Dalles. The effect on receiving water quality from stormwater discharges from a large retail facility was assessed in a report submitted to the Circuit Court of the State of Oregon. The detailed Expert Report was developed identifying the discharge conditions, storm flows based on local precipitation, storm flow mapping and routes, potential treatment levels using mechanical filtration and swales and other WQ issues. Water quality effects on receiving wetlands and tributaries of the Columbia River were investigated because of increased solids, toxics and bacterial loadings to be released from the proposed facility. Expert Testimony was provided in court supporting the evaluation report. This project was conducted in 2012 and 2013.

NPDES Mixing Zone and Water Quality Evaluations for Trident Seafoods Corporation, Alaska – Effluent characterization, discharge system configuration, receiving waterbody consideration, biological criteria and mixing zone evaluations were performed. Acting as subconsultant for Steigers Corporation. Facility operations generating wastewater discharges include: stormwater runoff inflow, seafood-processing wastewater, non-contact cooling water, treated sanitary effluent and other sources of industrial effluents. The MZ evaluations conformed to NPDES permit requirements and mixing zone guidelines for Trident facilities in Alaska at Akutan and Sandpoint. This project was performed from 2010 through 2012.

NPDES Water Quality Technical Assistance and Alternative Design Evaluations for North Slope Borough, Alaska – Evaluation of US Environmental Protection agency NPDES permit for discharges from oil and gas facilities including discharges from: stormwater system, drilling operations, cooling water intake and discharge, storage facilities, pipelines, gravel pits, treated sewage discharges, maintenance requirements, and other types of discharges. These discharges include stormwater affected deck drainage, cooling water intake and thermal discharges, treated sewage discharges and drill cuttings disposal to marine sediments. Water quality evaluation of the Camden Bay Exploration Plan for the Beaufort Sea of the Arctic Ocean was conducted for discharge impacts on the marine aquatic environment and relative to BOEMRE/MMS EIS. Analysis of the Chukchi Sea Exploration Plan of the Arctic Ocean was conducted for discharge impacts on the marine aquatic environment and relative to BOEMRE/MMS EIS. These evaluations were based on water quality and treatment alternatives assessment, and comparison to biological criteria. This project was conducted in 2010 through 2011.

Aurora STP NPDES Assessment for CRAG Law Center - Review of documents related to the design, operation and monitoring of the Aurora, Oregon Sewage Treatment Plant. Documents include: NPDES permit; stormwater inflow and infiltration, design related plans and specifications including recent headworks unit design; discharge monitoring reports, irrigation using effluent reuse, biosolids monitoring reports; effluent reuse plan and additional information relating to the design and operation of the Aurora STP. The review provided a basis for assessing potential causes of facility underperformance and discharge violations. An STP site visit was performed during this project to investigate facility aeration treatment, reuse equipment and capacities. This project was conducted from 2008 through 2010.

Review of the Medford STP Nutrient Related Discharges, for CRAG Law Center in Portland, Oregon. Evaluation of treatment facility and nutrient discharges from the Medford Sewage Treatment Plant (STP) into the Rogue River in Jackson County, Oregon. Existing discharges were evaluated for nutrient concentrations based on the discharger's CORMIX mixing zone analysis. Facility costs to upgrade for nutrient removal, including nitrogen and phosphorus, were developed. This project was performed in 2015 through 2017.

Evaluation of Sewage Treatment Plant Discharges to the Illinois River, Oregon, for the City of Cave Junction. Mixing zone analysis using EPA CORMIX was performed to determine the effects of temperature and other discharge parameters on river quality. Hydraulic analysis of river flow conditions was conducted to support the MZ analysis particularly for critical summertime conditions. This project was performed in 2013 through 2014.

Draper Valley Farms, Inc. Chicken Processing Industrial Discharge to Municipal Sewage System, for Smith and Lowney, PLLC representing the plaintiff Waste Action Project Citizens Suit. The effects on sewage treatment processes were evaluated relative to high biochemical oxygen demand (BOD) from Draper Valley Farms (DVF). A key focus of this analysis was the operational consequences of excess BOD on treatment in the aeration basins of the Mt. Vernon, WA municipal facility. The pass-through impact on the Skagit River was assessed for increased BOD from the industrial discharge. This project was conducted in 2014 and 2015.

Coal Discharge Investigation for the Columbia River and Selected Tributaries, for the Sierra Club supported by the Columbia Riverkeepers. Prospective coal samples were collected from sediments along 18 miles of the Columbia River located at the confluences of selected tributaries from Rock Creek (RM 150.0) to the White Salmon River (RM 168.3). Sampling locations corresponded to Burlington Northern Santa Fe (BNSF) railroad crossings at or near tributaries. The distribution of coal discharges into the Columbia River were mapped. Samples were analyzed by a third-party laboratory. Sample parameters were: moisture content, fixed carbon, volatile matter, ash and total sulfur. This was based on ASTM Proximate Analysis plus sulfur. Coal identification, to determine potential sources of coal, was completed for this investigation with the support of supplemental analysis advised by the laboratory. Supplemental analysis included ASTM D-388 requirements for heating value, sulfur in ash, free swelling index (carbonization physical characteristic) and classification of coal by rank. A deposition was provided in 2016 to defend the results of coal report. This project was performed in 2012 through 2013 and 2016.

Oregon Department of Environmental Quality - WQ Technical Assistance: Industrial discharge effluent evaluation of the Port of St. Helens, Oregon ethanol and power generating plants. Outfall mixing zone analysis with design assessment was developed. Provided water quality evaluation and environmental engineering assistance to the Oregon DEQ. Work included receiving WQ analysis, operations review, thermal discharge evaluation, biological criteria comparison and mixing zone analysis. NPDES requirements were based on EPA *Quality Criteria for Water*, EPA *Technical Support Document for Water-based Toxics Control* (TSD) and State Administrative Rules. The mixing zone models CORMIX and PLUMES were evaluated relative to the cases at hand. Potential discharge chlorine residual and temperature requirements were evaluated. The effect of potential temperature Total Maximum Daily Loads (TMDLs) in the Columbia River was also evaluated. This project was performed in 2003 through 2004.

Wauna Pulp and Paper Mill Outfall 003 and Columbia River Field Survey Locations and Sampling Results for Columbia Riverkeeper including sampling. In coordination with staff and volunteers, water samples were collected in the vicinity of the paper mill outfall for laboratory analysis. The physical outfall mixing zone was mapped using in-situ Hydrolab water quality measurements taken with depth for temperature, dissolved oxygen, pH, conductivity and turbidity. Laboratory samples were analyzed for potentially toxic concentrations of dioxins, total residual chlorine (TRC) and metals including aluminum, arsenic, copper, iron, lead, mercury and zinc. Additional information sources were investigated using the Oregon DEQ permit file and including the mill's NPDES permit and the mutual agreement and order (MAO) compliance schedule. This project was conducted in 2004.

Review of Draft and Final NPDES General Permit Cook Inlet, Alaska Oil and Gas Operators for Cook Inletkeeper - Evaluation of the draft National Pollutant Discharge Elimination System (NPDES) permit proposed by the U.S. Environmental Protection Agency (EPA) authorizing wastewater discharges from oil and gas exploration, development, and production facilities into Cook Inlet, Alaska. There are 18 existing facilities discharging into Cook Inlet with new facilities capable of being brought on line under the draft permit. Technical analysis of these discharges, which can contain toxic and bioaccumulating contaminants, was performed relative to the potential to adversely affect Cook Inlet water quality and sediments. This project was conducted from 2007 through 2009.

Water Quality Evaluations and NPDES Permit Requirements for the four (4) WES publicly owned treatment works (POTW) discharges (2000-2004, 1999) performed for Water Environment Services, Clackamas County, Oregon. These included evaluation of discharge effects on the Willamette River (2 outfalls), Sandy River and a tributary of the Clackamas River. Field water quality sampling including detailed outfall mixing zone investigations. Water quality assessment was conducted relative to effluent temperature, disinfection and ammonia requirements to protect fish and aquatic organisms. Effluent mixing zone simulation and analysis was performed. Treatment alternatives analysis and costing were undertaken to ensure existing and future discharge conditions were protective of river WQ. River outfall piping alignment and diffuser design was provided including construction management of river installation.

Expert Analysis of Surimi and Seafood Industrial Wastewater Discharge into the Skipanon and Columbia Rivers, Oregon (2003-2006) was conducted for the National Environmental Law Center. Water quality analysis evaluating the effects of seafood and surimi wastewater discharges on the Skipanon and Columbia Rivers, Oregon. Field data collection was performed to support water quality technical analysis. Investigation included mixing zone analysis of historic seafood and surimi wastewater discharges into the Skipanon River, and new discharges to the Columbia River. Evaluations were performed for various discharge scenarios, monitoring and sampling requirements, potential treatment options, and alternative outfall pipeline alignments. Effluent and instream dissolved oxygen (DO), biochemical oxygen demand (BOD), ammonia, hydrogen sulfide, nutrients nitrogen and phosphorus, oil and grease, and total suspended solids (TSS) were evaluated in detail. Expert witness analysis and reporting was provided.

Westport Sewer Service District, Clatsop County, Oregon - MZ Evaluation with Alternative Disinfection (2003-2004). This project assessed water quality and mixing zone effects of disinfected treated wastewater discharged to Westport Slough, a segment of the Columbia River. Chlorine residual reduction or elimination was a key evaluation concern to satisfy Oregon DEQ requirements. Comparisons of alternative disinfection treatment scenarios and costs were performed that would allow the discharger to continue to meet WQ requirements. Ultraviolet disinfection, chlorination-dechlorination, and outfall diffuser feasibility were all investigated with comparison costs. In particular, the existing chlorination system was evaluated relative to how easily it could be retrofitted to function with dechlorination. The alternatives analysis aided the discharger in making a determination as to course of action.

Public Employees for Environmental Responsibility preparation of report Effect On Puget Sound Chinook Salmon of NPDES Authorized Toxic Discharges as Permitted by Washington Department of Ecology (2005-2006). Industrial, municipal, stormwater and general facility NPDES permits were reviewed and analyzed relative to the presence of toxic contaminants in Puget Sound. Toxic contaminants evaluated included metals, hydrocarbons, and chlorinated hydrocarbons.

Citizens for Responsibility v. Izaak Walton League, Circuit Court of the State of Oregon for Lane County, Expert Analysis for Plaintiff evaluating the effects of lead contamination from shooting range into South Fork Spencer Creek (2004-2005). Sediment sampling was conducted for metals including lead, arsenic, copper and polynuclear aromatic hydrocarbons (PAH). This information was evaluated for pollutant distribution and transport from the contaminated site and relative to upstream and downstream properties. Expert testimony was given at trial in 2004. Expert analysis and testimony was also provided in the subsequent equitable relief phase. Participation in the settlement conference was also provided.

Canby Utility Board - Industrial Discharge from Water Treatment Plant Study and Predesign (1999-2000) addressing Molalla River water quality issues with Oregon DEQ including treatment alternatives: filter backwash sedimentation basin, disinfected effluent de-chlorination, river infiltration gallery design, intake piping system, and sediment and riparian effects mitigation.

Water Environment Services of Clackamas County Hoodland WWTP Outfall Project Descriptions and Costs (2000); FEMA engineering, budgeting and negotiations is intended to reimburse Clackamas County for flood damage to their wastewater treatment plant outfall on the Sandy River. Numerous regulatory issues affected costs including an ACE 404 permit for instream construction work, NMFS ESA Section 7 Consultation, and NEPA documentation including environmental and biological assessments.

City of Bremerton, CSO Projects --A comprehensive review of the City of Bremerton, Washington collection system model was performed (2000). Hydraulic modeling was used to update information for the main sewer lines, combined sewer overflows and discharge conditions. Selected CSO reduction alternatives were evaluated and implemented. The purpose of the CSO reduction alternatives was accomplished and potential early action projects were identified. These projects yielded substantial CSO reductions while being quickly implemented at reasonable cost. Revised CSO baselines were produced conforming to Washington Department of Ecology requirments for Bremerton's 17 CSO outfalls. Expert witness testimony supporting the findings of the CSO baselines was provided in a hearing at the Federal Court in Seattle.

Previous Experience (Montgomery Watson Americas)
In addition, I have performed as project manager and/or project engineer on the following undertakings:

- Project Manager/Engineer evaluating stormwater hydrologic, hydraulic and quality conditions in Balch Creek Basin for the City of Portland, Bureau of Environmental Services, Oregon. The Army Corps of Engineers (COE) hydrographic model, (HEC-1) and hydraulic model (HEC-2) were applied to establish design criteria for flood magnitude, stormwater detention, water quality facility hydraulics and fish passage culvert hydraulics.

- Project Engineer evaluating stormwater hydrologic, hydraulic and quality conditions in Clackamas County for the CCSD#1. The graphically enhanced model, XP-SWMM, was used to develop the hydrology and hydraulics for the Kellogg and Mt. Scott Creeks basins in CCSD#1.

- *City of Portland, Bureau of Environmental Services* included Water Quality Evaluations and Diffuser Designs (2000-2001, 1997,1994) for wet and dry weather flows with chlorine residual discharges, and wet weather stormwater runoff for suspended solids and metals with potentially affected agencies including US Corps of Engineers, Oregon Division of State Lands, NOAA Fisheries, Oregon Dept. of Fish and Wildlife and US Fish and Wildlife.

- Project Manager/Engineer for the Kensington Mine in Alaska. PLUMES mixing zone modeling was used to evaluate the conditions affecting this industrial outfall. Sedimentation basin design for removal of mine tailings prior to discharge to Lynn Canal.

- City of Bremerton Corrosion and Fluoridation Facility detention facility design. An on-site detention facility was designed pursuant to Washington Department of Ecology's requirements as specified in the *Puget Sound Stormwater Management Manual*.

- Project Engineer for Water Environment Services of Clackamas County Kellogg Creek WWTP Odor Control Project. Participated as team engineer to design malodorous air collection system for headworks, primary clarifiers, secondary clarifiers, and dissolved air floatation thickening (DAFT) building. Malodorous air was passed through a biofilter for treatment.

- Project Engineer for Crescent City, California WWTP outfall mixing zone analysis. A major consideration of this project was developing alternative outfall pipeline alignments and an effective discharge location to optimize mixing.

- Project Manager/Engineer for the Hoodland WWTP Outfall project, which includes outfall diffuser design and construction (1998) in a sensitive Sandy River corridor.

- Project Task Manager—Jefferson County (Birmingham, Alabama) stream water quality analysis was performed relating to recommended NPDES permit limits for dry and wet weather conditions. Collection system analysis and treatment plant design constraints are also considerations in this potentially very large project.

- Project Engineer using Pizer's HYDRA, data compatible with the City of Portland, Oregon's XP-SWMM format, to evaluate gravity flow conditions in the proposed dual outfall system consisting of two connected parallel outfall systems over one mile each and including wet weather (CSO) hydraulic structures such as flow control structures, mix boxes and outfall diffusers.

- *City of Madison, Wisconsin* - stream water quality modeling analysis of POTW discharge relative to NPDES permitting requirements (1995-1996). A key objective of this study was restoration of base flows to the Sugar River Basin using high quality POTW effluent. An EPA QUAL2E model was developed for Badger Mill Creek and the Sugar River. Physical, chemical and biological simulation included temperature, algae, dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended solids (TSS) and ammonia. Particular attention was focused on the inter-relationships between temperature, climatological conditions, stream shading and channel conditions, DO, BOD and algal activity. Temperature and discharge point design alternatives were investigated using the model. It was demonstrated that, with minimal WWTP facility upgrading and cost, the City could beneficially discharge high quality effluent to surface streams. This assurance was primarily accomplished through detailed modeling analysis and model approach consensus building with regulators (WDNR). Some keys to the success of this project were in identifying important NPDES permitting issues, evaluating them with the model, recommending permit effluent limits and negotiating with regulators.

- *Washington Beef, Incorporated* in Toppenish, Washington – Development of an NPDES permit under the direction of the EPA (1993-94). The project objective was development of receiving water based permit effluent limits for this food-products industry discharger using dissolved air floatation (DAF) treatment. Important project elements were: interfacing with regulatory (EPA Region 10 and Washington Ecology) and public agencies; evaluation of the effect of effluent parameters on receiving water using modeling analysis (EPA QUAL2E and EPA CORMIX); and providing long-term treatment system design recommendations. Fishery issues were of key concern for this project. Receiving water modeling was used to analyze the discharge effects of on stream dissolved oxygen and temperature on the aquatic environment. The inter-relationship between temperature, climatological conditions, stream shading and channel conditions, DO and algal activity were thoroughly investigated. Temperature and discharge design alternatives were evaluated using the water quality model.

Previous Experience (Other Firm)

- *Oregon Department of Environmental Quality and Oregon Department of State Land Conservation and Development* - Non-point Source Pollution Control Guidebook for Local Government (1994) evaluation of non-point runoff pollution and control measures including detention facilities, sedimentation basins, water quality ponds and marshes; City of Portland, Bureau of Environmental Services (1989-90) - evaluated effects of combined sewer overflows and stormwater discharges on the Columbia Slough of the Columbia River. Hydrologic and water quality modeling support was provided including sampling.

- Project Engineer for NPDES waste discharge permit review and support related to permit effluent limits for the City of Vancouver, Washington. Two tracer dye studies were performed at their two municipal WTP outfalls. The key project objective was to determine actual outfall dilution and provide a physical, receiving water basis for setting permit effluent limits. The mixing zone evaluations showed that actual dilution was greater than estimated by the regulatory agency (Washington Department of Ecology) and higher permit effluent limits were recommended.

- Project Task Manager and Engineer for a comprehensive hydraulic and water quality compliance evaluation and recommendations. The City of Portland's Columbia Boulevard WTP, the largest municipal discharger in Oregon (300 MGD), required assistance in meeting their water quality compliance needs. A highly detailed Columbia River tidal flow evaluation was performed in the outfall vicinity to serve as the basis for the mixing zone simulation and diffuser design. EPA CORMIX, and the EPA supported PLUME model family (including UDKHDEN), were used in the modeling analysis. A thorough investigation of water quality compliance options led to regulatory (ODEQ) approval of the multi-port diffuser design, the lowest cost compliance option.

- Project Engineer for Kehei, Hawaii Water Reuse Facility (1992). Participated as team engineer to design upgrades to the facility’s aeration basin including aeration blower design and aeration basin air piping with small bubble diffusion.

- Project Engineer for the Columbia Slough flow augmentation project for the City of Portland Bureau of Environmental Services, Oregon. Dynamic water quality modeling (COE CE-QUAL-W2), water quality sampling, and hydrodynamic sampling were performed for this dynamic "freshwater" estuary. This project was driven by the City's need to evaluate the impact of water quality limited conditions on the Columbia Slough and was coupled to the City's EPA SWMM model. The objective was to propose best management practices (BMP) and evaluate design alternatives. The effect of temperature on the aquatic environment was examined in detail. The sophisticated two-dimensional (vertical and longitudinal) dynamic model evaluated temperature regimes and their effect on in-stream water quality. In-stream temperature design alternatives were investigated via simulation of climatological conditions, stream shading and channel conditions, algal processes and kinetics, and instream DO.

- Project Engineer conducting stormwater hydrologic and hydraulic simulation to evaluate flood effects for the City of Beaverton, Oregon. HEC-1 hydrographic modeling was conducted to generate peak flow values from surface runoff for existing and future conditions. HEC-1 model results for 2, 5, 10, 25, 50 and 100-year storm events were supplied to the HEC-2 model for detailed hydraulic analysis. The HEC-2 modeling was required as part of a cost assessment that included potential flood damage of key storms.

- Project Manager and Engineer for a mixing zone evaluation and diffuser design for the City of Albany, Oregon. An outfall pipeline and 40 MGD capacity multi-port diffuser was designed for this municipal discharger using EPA CORMIX. Simulation was performed to optimize the diffuser design. The DEQ approved design will meet water quality compliance needs for chlorine and ammonia.

- Project Engineer mixing zone modeling and design for the City of Gresham, Oregon. Alternative disinfection and multiport diffuser design were evaluated. Modeling (EPA CORMIX) was utilized to optimize multiport diffuser design for this WWTP outfall. Simulation offered the flexibility to test numerous design conditions.

- Project Manager and Engineer for a mixing zone evaluation and diffuser design for the Unified Sewerage Agency, Washington County, Oregon. Analysis of four municipal treatment facility outfalls was conducted according to DEQ NPDES requirements. Model simulation was performed to determine revised wet weather chlorine residual effluent limits. The models were calibrated to dye study results. Wet weather stream surveys were also performed at two sites, Hillsboro and Forest Grove. Alternative disinfection was evaluated and diffuser design recommendations were also made.

- Project Manager and Engineer for outfall mixing zone simulation and water quality compliance evaluation for the Oak Lodge Sanitary District, Oregon. As part of NPDES permit requirements, model simulation was performed to characterize the municipal discharge-mixing zone. Available dilution values and recommended permit effluent limits for chlorine, ammonia and metals were derived from the study.

- Project Manager for a mixing zone evaluation and diffuser recommendations for Electronic Controls Devices, Incorporated. A mixing zone field evaluation of this circuit board manufacturer's discharge was performed. Very low amounts of organics and metals from the facility discharge needed to be discharged to a small stream in a responsible manner. This study illustrated that the discharge was well within compliance requirements.

Previous Experience (Portland State University Research Assistant)
City of Portland, Bureau of Environmental Services (1989-90) - evaluated effects of combined sewer overflows and stormwater discharges on the Columbia Slough of the Columbia River. Hydrologic and water quality modeling support was provided including field sampling.

- Project Engineer for evaluation of fish screen approach velocities and hydraulic design analysis for the Eugene Water and Electric Board, Leaburg, Oregon. The effects of downstream baffles on velocities through fish screens at the Leaburg Power Canal Facility were evaluated for fish passage.

- Project Engineer evaluating combined sewer overflows (CSO) and stormwater discharges on the Columbia Slough. Hydrologic and water quality modeling, using the City's EPA SWMM model data, of urban runoff from sub-basins discharging to the Columbia Slough was supplied as input to the Army Corps of Engineers in-stream surface water model, CE-QUAL-W2. This study was performed for the City of Portland, Bureau of Environmental Services in Oregon.

- Project Engineer for the South Slough National Estuarine Reserve Hydrodynamic and Water Quality Study, State of Oregon, Division of State Lands, Charleston, Oregon. Dynamic water quality modeling, water quality sampling, and hydrodynamic sampling were performed for this southern section of the Coos Bay estuary. Tracer (rhodamine) dye study results were used to calibrate the Army Corps of Engineers CE-QUAL-W2 model.

- Project Engineer for design of stream flow measurement structures on two tributaries of the South Slough National Estuarine Reserve (State of Oregon, Division of State Lands) in Charleston, Oregon. Analysis and design of stream flow measurement structures was required as part of a study assessing the hydrology and hydraulics of this pristine estuary.

- Project Engineer for a hydrologic, hydraulic and water quality assessment of Smith and Bybee Lakes in Portland, Oregon. Lake sampling and modeling was performed. The objective of the study was to evaluate the potential for water quality impairment due to the close proximity of St. John's municipal landfill and Columbia (North) Slough inflow. A hydraulic model of possible flow control structures was incorporated into the Army Corps of Engineers CE-QUAL-W2 hydrodynamic and water quality model. Recommended actions were advanced for improving lake water quality based on simulation scenarios. This study was conducted as part of a larger study for the Port of Portland, Metropolitan Service District, and City of Portland, Bureau of Environmental Services, Portland, OR.

- Project Manager and Engineer assessing the water quality impact of urban runoff from the Leadbetter storm outfall discharge to Bybee Lake. This study was conducted for the Port of Portland, Portland, Oregon.

- Project Engineer assisting in initial field work and model development for assessing impact of landfill leachate on surrounding surface waters. Conducted for the Metropolitan Service District (METRO) as part of the St. Johns Landfill closure.

Publications and Presentations

Stream Temperature Trading, Presented at the Pacific Northwest Pollution Control Annual Conference, 2001, Bend, Oregon.

Winter Temperature Gradients in Circular Clarifiers (January 1999), *Water Environment Research*, **70**, 1274.

Wet Weather River Diffuser Port Velocities: The Energetic Debate, Presented at the Pacific Northwest Pollution Control Annual Conference 1998, Portland, Oregon.

Near Field Mixing and Regulatory Compliance Implications Presented at Portland State University, February, 1998.

Whither the Wet Weather Flow, Presented at the Pacific Northwest Pollution Control Annual Conference 1997, Seattle, Washington.

Supplement B: Part 1 – Analysis Report

Included under separate cover because of size.

Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property (LEA, November 2016)

Contracted by John and Grace Lucini, 23677 SW Boones Ferry Road, Washington County, Oregon, Tualatin, Oregon, 97140.
This report is referred to as the "Stormflow Analysis" throughout these comments.

Effects of SW Boones Ferry Road Construction (2013-2015)

Stormflow Analysis for the Lucini Property

Washington County, Oregon

Prepared for

John and Grace Lucini

23677 SW Boones Ferry Road

Tualatin, Oregon

97140

REGISTERED PROFESSIONAL ENGINEER 18,645 OREGON JULY 20 1993 DAVID M La LIBERTE

Prepared by

Dave LaLiberte

Principal Engineer

Liberte Environmental Associates, Inc.

Wilsonville, Oregon

LEA

November 1, 2016

1. Summary

Beginning in about 2015, Washington County, Oregon re-routed and increased the portion of stormwater flows passing through its road culvert (Outfall #5). These increased stormflows are associated with the County's SW Boones Ferry Road (BFR) Improvement Project. A location map is presented in Figure 1 showing the Lucini property relative to the County's road project. The re-routed portion and increased stormwater ultimately discharge onto the Lucini property[1]. Figures 2 and 3 show the stormwater conveyance through the steeply sloped Lucini property, which is composed of pipes and ditches. The photos in Appendix A document drainage condition problems on the Lucini property associated with the road project.

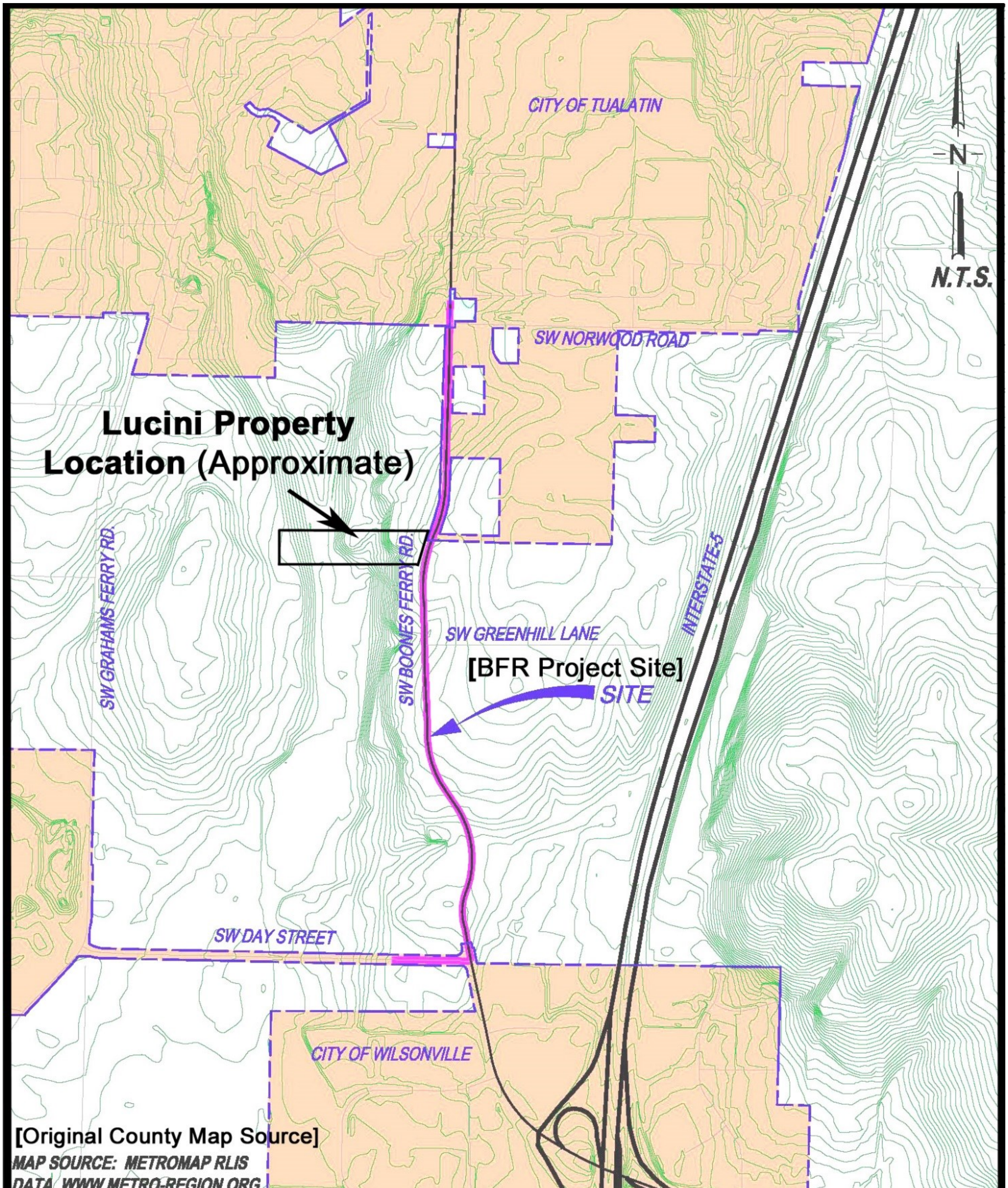
Increased portions of stormflows are now routed to the Lucini property but the County did not acknowledge this condition in its planning document, which is identified throughout this report as the *Drainage Report* (2013).[2] Figure 4 shows the erroneous subbasin boundaries used by the County in its Drainage Report. Figure 5 shows the necessary corrections to the faulty subbasin boundaries. These corrected subbasin boundaries demarcate a smaller actual subbasin acreage draining to the Lucini property, which results in lower stormflows than those projected by the County for ORIGINAL conditions prior to 2013. Appendix B provides the Drainage Report figures pertaining to overall subbasin boundaries for "Existing Conditions Hydrology", called throughout this report as the ORIGINAL conditions; and the "Proposed Conditions Hydrology", i.e., IMPLEMENTED conditions.

Photos and Drawings Documentation
The County claims in the Drainage Report that the ORIGINAL Boones Ferry Road above the Lucini property prior to 2013 was curbed and included storm sewers. However, the photos in Appendix A1 show that there are no curbs or storm sewer inlets. The County's mischaracterization of stormflow conditions, and depriving the public of accurate land contour information, allowed the County to shift a portion of flows from the adjacent and sensitive Greenhill Lane subbasin and into the subbasin above the Lucini property generating significant problems with erosion and flooding.

Appendix C contains the "Existing Conditions Plan" (June 2012) from the County's 70 percent drawings submittal related to the subbasin above the Lucini property. The drawings contain no elevation labeling nor do the unlabeled contour lines support the County's claim that the majority of stormflows in this area originally ended up passing onto the Lucini property.

[1] John and Grace Lucini property is located at: 23677 SW Boones Ferry Road, Tualatin, Oregon, 97140.

[2] Drainage Report (2013), Storm Drainage Report – SW Boones Ferry Road (SW Day Road to SW Norwood Road, by MacKay Sposito for Washington County, Capital Project Management (CPM), Final January 31, 2013.



Background Image from Washington County's *Storm Drainage Report for SW Boones Ferry Road* Appendix A2 - Site Map figure on PDF page 27 of 152 (January 31, 2013).

Figure 1. Location Map Showing Lucini Property Overlay and Proximity to the SW Boones Ferry Road Improvement Project

These problems were not corrected in the construction plans for the project related to the subbasin above the Lucini property as shown in the final as-built drawings (November 2014) available in Appendix D. The County's "Erosion and Sediment Control Plan" from the as-built drawings as it relates to the subbasin draining to the Lucini property are contained in Appendix E. These drawings show that the original contours allowed stormflow to enter the road right-of-way and then flow south into the adjacent Greenhill Lane subbasin, not the subbasin draining into the Lucini property.

The storm flow increases overwhelmed the existing downstream conveyance system causing substantial erosion and flood damage to the property in May 18, 2015. Photos of flood damage are presented in Appendix A2. Still more flood damage is threatened in future years as the County has not protected the Lucini property from increased flows in an area that is rapidly urbanizing. Appendix A3 contains photos of erosion damage on the Lucini property resulting from increased stormflows that erode soil, widen the conveyance ditch into the adjacent embankment and expose tree roots.

In its Drainage Report, the County has departed from its stated stormwater guidance identified in Clean Water Services (CWS).[3] In particular, the County did not carry-out a Downstream System[4] evaluation for the Lucini property as necessitated in its guidance. This evaluation process is used to determine the potential effects of increased storm flows on the property. The effects of ongoing and future development in the drainage above the Lucini property are neglected in the County's Drainage Report for the ORIGINAL (pre-2013) and IMPLEMENTED (2015) subbasin conditions.

The County disregarded increased stormflow effects, above the Lucini property, resulting from more intense ongoing and future urbanization in the subbasin. Near-term increases in land use intensity were also neglected as the Drainage Report did not acknowledge the County's own construction impact on the subbasin above the property. Increased stormflows, generated from the more intensely urban "Institutional" category associated with the City of Tualatin, are entirely overlooked by the County.

Purpose of this Stormflow Analysis
This Stormflow Analysis report is performed in lieu of Washington County carrying-out an accurate assessment of ORIGINAL (prior to 2013) and IMPLEMENTED (2015) drainage conditions upstream and through the Lucini property.

The U.S. Army Corps of Engineers (Corps) model, HEC-HMS[5], is used in this analysis to evaluate rainfall hydrology. Model inputs include precipitation time distributions and amounts, drainage area sizes, land use and soil conditions, runoff time-of concentration,

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[3] CWS (2007), *Design and Construction Standards for Sanitary Sewer and Surface Water Management*, for Clean Water Services (CWS), Hillsboro, Oregon, June 2007.

[4] Ibid, see Chapter 2, Page 12 under the 2.04.2 subsection heading "3. Review of Downstream System", i.e., this is subsection 2.04.2.3.

[5] HEC refers to the U.S. Army Corps of Engineers Hydrologic Engineering Center; and the HMS refers to the Hydrologic Model System.

stormwater routing and other parameters are considered for evaluating storm flows onto and through the Lucini property.

The hydrologic analysis performed in this report was first adjusted to the Washington County hydrologic results presented in its Drainage Report for the corresponding Soil Conservation Service (SCS) Type IA 25-year design storm. Then the corrected subbasin areas and land use conditions were supplied to the HEC-HMS hydrologic model so that realistic storm flow conditions could be simulated.

The County's Drainage Report did not perform a hydraulic analysis to assess the effects of stormflows above and through the Lucini property. The Corps hydraulic model, HEC-RAS[6], is used in this analysis to overcome the lack of hydraulic information. Peak flows from 25-year rainfall runoff, generated by the hydrologic model HEC-HMS, are supplied as inputs to the HEC-RAS hydraulic model. HEC-RAS is run in steady state mode, i.e., peak stormflows are held constant for each run. This process allows for the consideration of the impact of stormflows on piping, ditches and other features of the drainage system. Specifically, the hydraulic effects resulting from stormflows passing through the drainage system subbasins, stormflow routing, ditches, culverts (piping), land use conditions, ditch and piping materials, and other parameters can be assessed.

Hydrologic Modeling Results

The hydrologic simulation inputs and stormflow results generated by HEC-HMS for the subbasin above the Lucini property are contained in Appendix H.

The hydrologic modeling considered a number of probable realistic cases unexamined in the Drainage Report for the 25-year design storm. The ORIGINAL subbasin configuration as depicted in Figure 4, which is corrected as shown in Figure 5. The hydrologic model was then run with the more accurate drainage area as the ORIGINAL subbasin configuration. This comparison demonstrates that the realistic (actual) peak flow value of 0.89 cubic-feet-second (cfs) discharging to the Lucini property is 31.5 percent less (see the Figure 6 column chart) than peak flow of 1.17 cfs claimed in the County's Drainage Report. This is critically important because the County is inflating the ORIGINAL stormflows and makes it seem like the ORIGINAL condition had higher flows. This is an adverse condition for the Lucini's because the Drainage Report analysis later claims to reduce the ORIGINAL stormflow amount that it previously inflated as part of the IMPLEMENTED project.

Stormflow values are graphically compared in the Figure 6 through Figure 8 column charts. Figures 9 and 10 show the subbasin boundaries for IMPLEMENTED conditions, which permanently re-rout stormflows from a portion of the Greenhill Lane subbasin ultimately onto the Lucini property

Still greater stormflow inaccuracies are introduced by the County because it did not consider fundamental increases in impervious land areas resulting from ongoing and future land use. This is a basic necessity identified in the CWS (2007) guidance, which

[6] HEC-RAS refers to the River Analysis System hydraulic model developed by the Corps.

the County is claiming it is relying upon. It can be seen that ongoing land use and future full build-out development conditions result in much larger stormflows being discharged to the Lucini property.

Ongoing land use considerations include road construction activities and large facility support conditions necessitated by the Horizon Community Church. These land use conditions can be seen in the aerial view presented in Figures 13 and 14. Appendix F also displays additional land use characteristics in the subbasin above the Lucini property. Road construction activities result in soil compaction from heavy equipment movement and parking as well as materials staging and other provisions necessitated by road construction. Figures 13 and 14 also show the sprawling Horizon Community Church complex that relies in part on the subbasin draining to the Lucini property. The church facilities include a driveway, service roads, vehicle parking, facility support buildings and other impervious features affecting runoff.

When realistic ongoing land use is considered, stormflows discharged to the Lucini property are projected to inflate to 92.1 percent of the ORIGINAL conditions (see middle column in Figure 7). When stormflows from ongoing land use are compared to IMPLEMENTED conditions, the Lucini property is projected to receive 204.7 percent of the realistic (actual) original stormflows based on implemented conditions (see middle column in Figure 8).

The majority of the subbasin above the Lucini property is slated for intense future development allowed within the 20-year future development (FD20) planning. The County disregarded this condition in its Drainage Report and is subjecting the Lucini property to significant burdens from future erosion and flooding. When realistic future full build-out development is considered, stormflows discharged to the Lucini property are projected to inflate to 220.2 percent of the ORIGINAL conditions (see right column in Figure 7). When stormflows from full build-out conditions are compared to IMPLEMENTED conditions, the Lucini property is projected to receive 414.1 percent of the realistic (actual) original stormflows based on implemented conditions (see right column in Figure 8).

Hydraulic Modeling Results
The hydraulic modeling presented in this analysis evaluates the ORIGINAL and IMPLEMENTED piping and ditches on the Lucini property (see Figures 2 and 3) as well as the County's system above the Lucini property (see Figures 11 and 12).

Figure 11 shows the hydraulic conditions for connecting piping and the original road culvert locations for the ORIGINAL configuration. Figure 12 illustrates the IMPLEMENTED hydraulic conditions consisting of connecting piping and the new culvert comprising the County's Outfall #5. Figure 12 also shows the juxtaposition of the old and new Boones Ferry Road that hydraulically affects flows to the Lucini property.

The hydraulic simulation inputs and results, including stormflow water surface profiles and velocities, generated by HEC-RAS are available in Appendix I. The hydraulic modeling assessing pipe and ditch flow conditions shows that excessive stormflow velocities are created on the steep slopes of the Lucini property. The estimated land profiles of the storm water conveyance is illustrated in Figure 15 and Appendix I).

Stormflow velocities shown in Figure 16, for a range of land use conditions and the ORIGINAL subbasin configuration, demonstrate many instances where values exceed velocities that cause erosion on the Lucini property. These velocities exceed 4.0 feet-per-second (fps) and cannot be maintained. This deleterious situation requires measures to reduce peak flows coming through the County's culvert (Outfall #5) and onto the Lucini property. The physical conditions of excessive and increased streamflow on steep slopes existing on the Lucini property, and compared to the ORIGINAL conditions, were not evaluated by the County in its Drainage Report.

Stormflow velocities shown in Figure 17, for a range of land use conditions and the IMPLEMENTED subbasin configuration, demonstrate that values exceed velocities that cause erosion on the Lucini property for the ongoing land use and full build-out development conditions. These velocities exceed 4.0 feet-per-second (fps) and cannot be maintained. This harmful condition requires methods to reduce peak flows, including sediment and debris transport, passing through the County's culvert and onto the Lucini property. The physical conditions of excessive and increased streamflow on steep slopes existing on the Lucini property, and compared to IMPLEMENTED conditions, were not evaluated by the County in its Drainage Report.

Planning Level Costs
Three levels of estimated capital costs are related to remedying problems on the Lucini property resulting from the County's SW Boones Ferry Road widening project:

1) Immediate Shorter Term Remedy using Orifice Plate ($4,500 to $6,500 installed)
2) Ongoing Flow and Water Quality Control Facilities ($12,157 to $17,560 installed)
3) Longer Term Detention/Retention Facilities (to several hundred thousand dollars)

These capital costs include equipment, materials, labor, and construction contractor overhead and profit. Design, engineering and construction management costs are separately considered. An estimate of 20 percent of the final construction capital cost for this relatively small scale project is considered. For the high range estimates above, the design cost estimates are $1,300 for number 1 and $3,572 for number 2.

Notes:

[1] Background aerial image source from 2012-04-02 Map Boones Fry Rd FINAL_ EXHIBIT_AERIAL WA County.pdf. Five (5)-foot contours overlaid from 2013 Boones Ferry Road Wetlands and Contours from Metro Data Resource Center.

[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

[3] Original Connecting Piping, about 42-foot long, 15-inch corregated metal pipe (CMP). Overlay from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

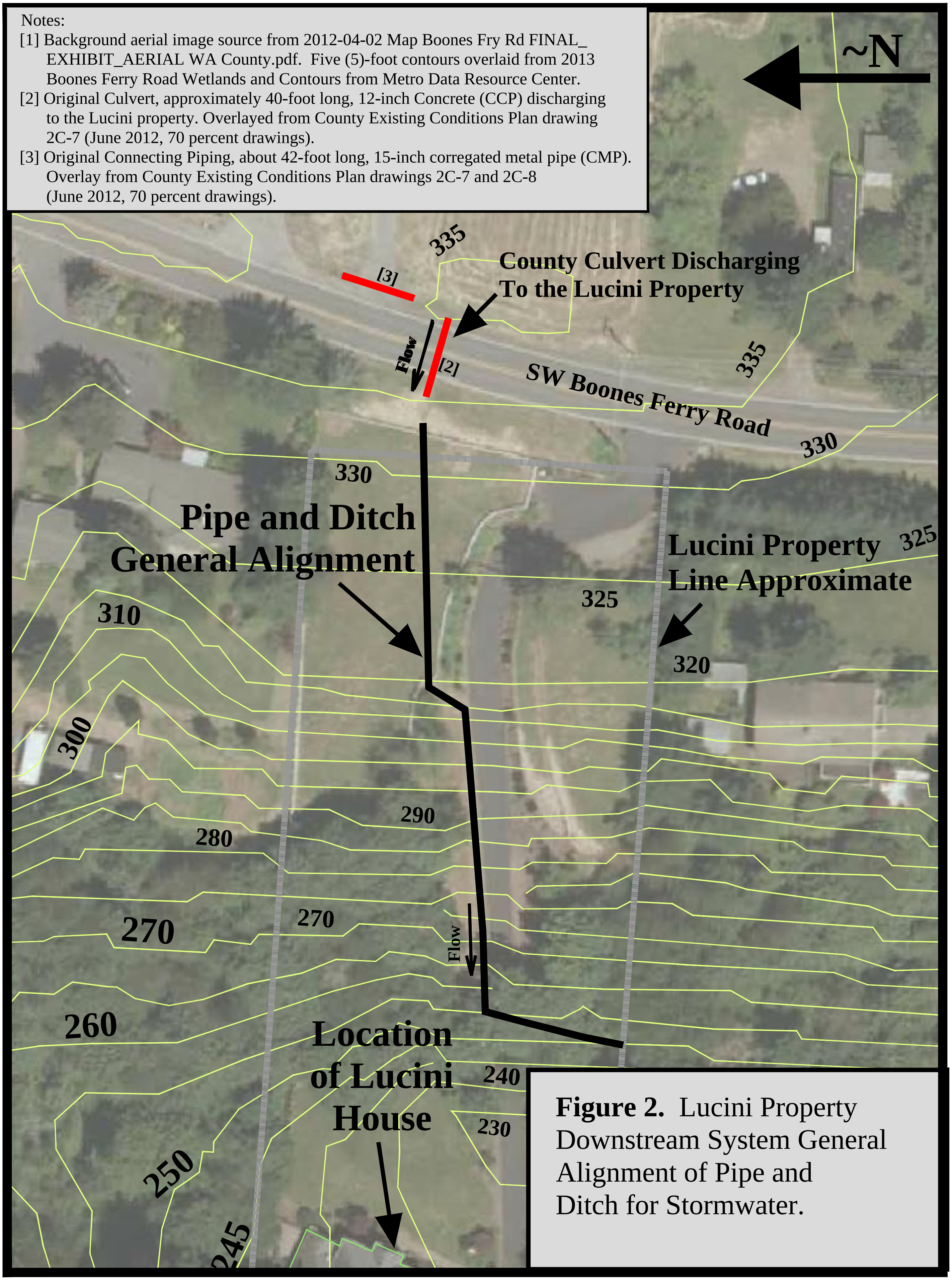

Figure 2. Lucini Property Downstream System General Alignment of Pipe and Ditch for Stormwater.

Notes:

[1] Background aerial image source from 2012-04-02 Map Boones Fry Rd FINAL_EXHIBIT_AERIAL WA County.pdf. Five (5)-foot contours overlaid from 2013 Boones Ferry Road Wetlands and Contours from Metro Data Resource Center.

[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

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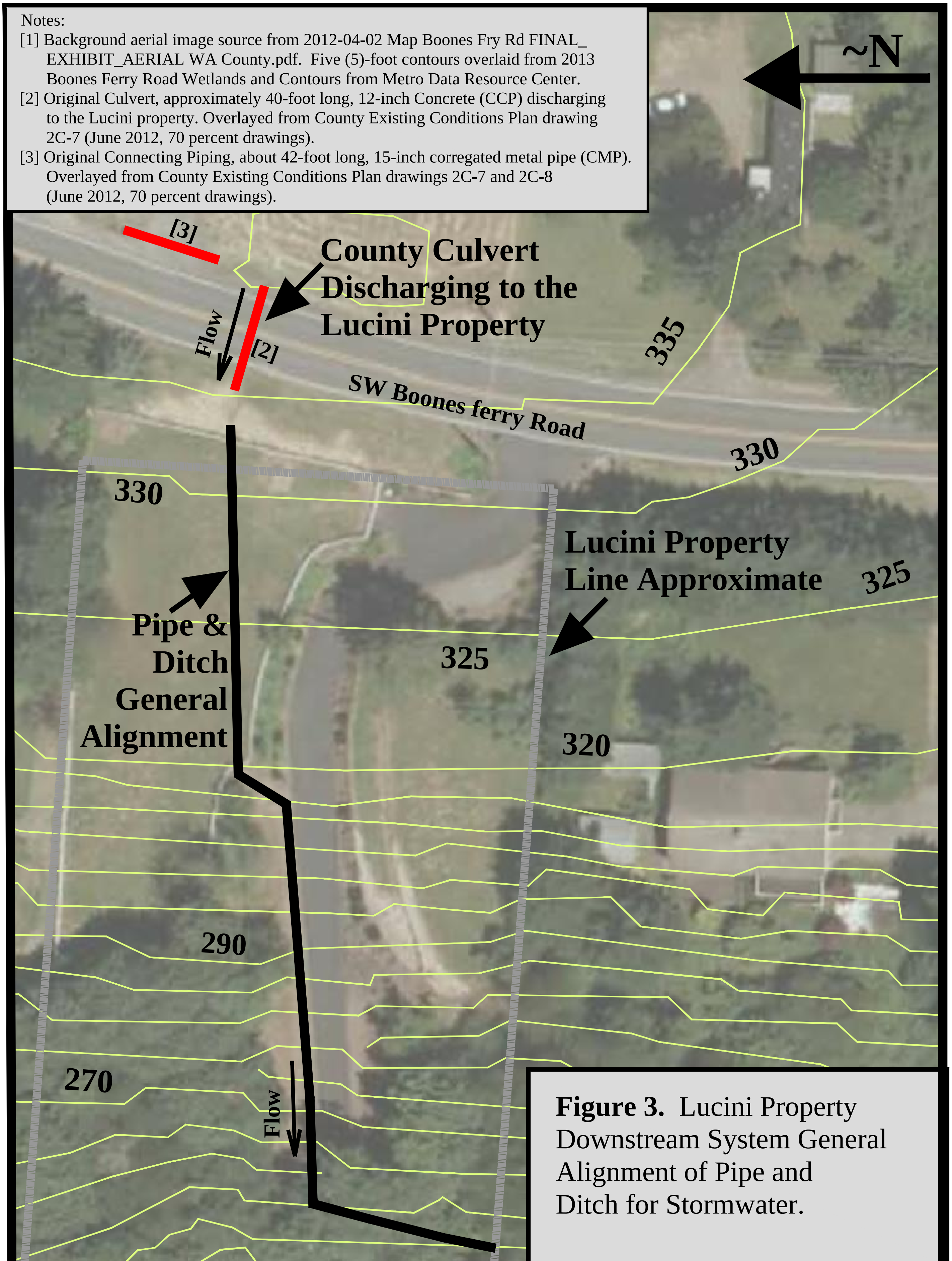


Figure 3. Lucini Property Downstream System General Alignment of Pipe and Ditch for Stormwater.

2. Background

This investigation begins with the ORIGINAL subbasin (Figures 4 and 5) stormflow conditions affecting the Lucini property and resulting from the SW Boones Ferry Road improvements project (approximately years 2013-2015). Unlike the County's Drainage Report (2013) that only considered very limited runoff hydrology, this study includes comprehensive stormflow hydrology and hydraulics comprised of the pipes and ditches upstream of, and on, the Lucini property.

Hydrology and Hydraulics

The hydrologic analysis performed in this report employs the U.S. Army Corps of Engineers (Corps) model called HEC-HMS.[7] The LEA model analysis was adjusted to the Washington County results for the initial corresponding design storm. The same Soil Conservation Service (SCS) design storm event[8] was used for both the Washington County and the LEA hydrologic analysis presented in this report.

The Washington County storm flow results affecting the Lucini property are compared in Tables 2 and 3, and are based on the SCS 25-year design storm event for ORIGINAL and IMPLEMENTED stormflow conditions, respectively.

For Original conditions, the County stated a peak storm flow of 1.17 cubic-feet-per-second (cfs) for the design storm event. The LEA hydrologic model analysis employing HEC-HMS produced the same storm flow results as the County. This LEA-County results calibration used the same model inputs as the County[9], for the supposed ORIGINAL drainage area, runoff curve numbers, and other corresponding parameters.

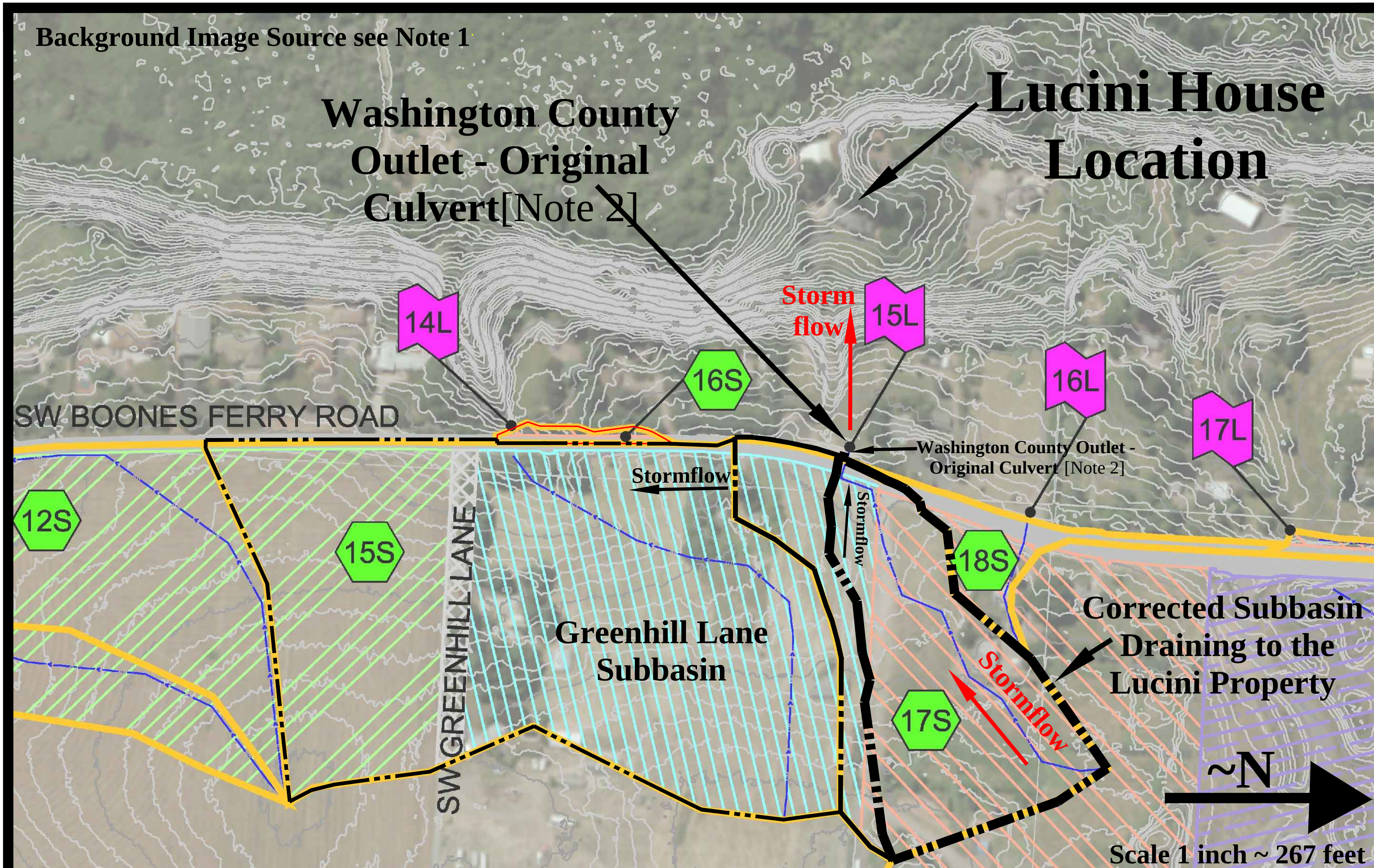
For IMPLEMENTED conditions, the County projected a peak storm flow of 0.85 cfs for the design storm event. The LEA hydrologic model analysis, employing HEC-HMS, produced the same storm flow results as the County. This LEA-County results calibration used the same inputs for the Implemented drainage area, runoff curve numbers, and other corresponding parameters.

Photos of the Lucini Property taken during the May 18, 2015 storm event are shown in Appendix A2. These photos demonstrate the excessive flow velocities generated at the site for storms even less than the 25-year event.

[7] HEC refers to the U.S. Army Corps of Engineers Hydrologic Engineering Center. HMS refers to the Hydrologic Model System.

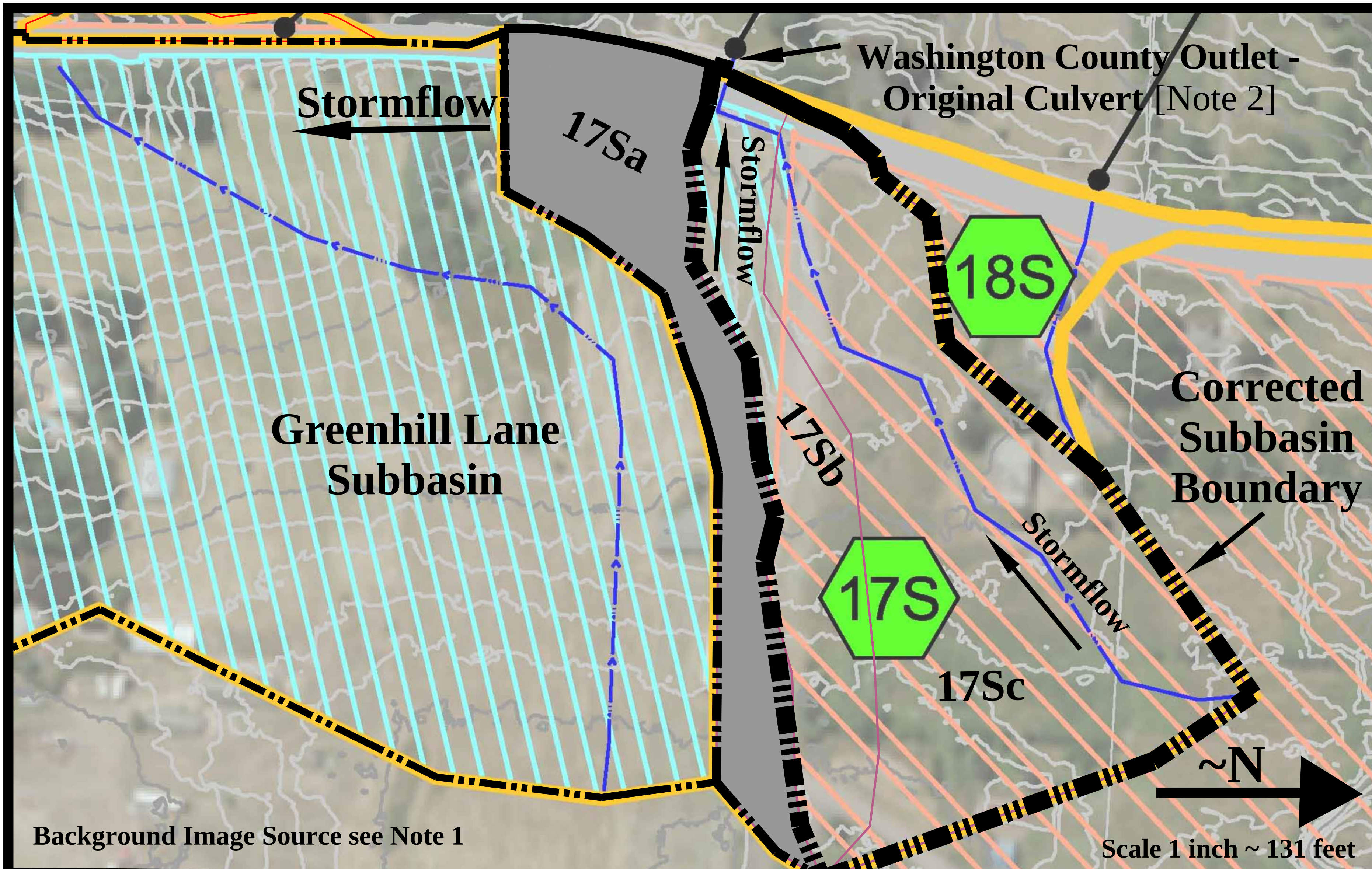
[8] The design storm is defined herein as the 24-hour, 25-year Type IA developed by the Soil Conservation Service (SCS). This the same design storm event as used by Washington County in its Drainage Report.

[9] The County employed the commercially available HydroCAD software program to carry out the hydrologic calculations using the SCS design storm method.



Notes:
[1] Background image source from Washington County *Storm Drainage Report* (January 2013), Existing Conditions Hydrology Map on PDF Page 35 of 152.
[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).
[3] Original Connecting Piping, about 42-foot long, 15-inch corregated metal pipe (CMP). Overlayed from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

Figure 4. Original County Subbasins - Erroneous Boundaries for Drainage above the Lucini Property.



Notes:

[1] Background image source from Washington County *Storm Drainage Report* (January 2013), Existing Conditions Hydrolgy Map on PDF Page 35 of 152.

[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

[3] Original Connecting Piping, about 42-foot long, 15-inch corregated metal pipe (CMP). Overlayed from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

Figure 5. Original County Subbasins - Erroneous Boundaries for Drainage above the Lucini Property. (Close-in View)

The County's Drainage Report (2013) indicates it is relying upon CWS 2007 for storm flow evaluation methodology, which requires a "Review of Downstream System"[10], especially when flow increases are likely under present and future conditions. No Downstream System review exists in the Drainage Report for the storm water culvert flow draining to the Lucini property.

Despite supposed lower stormflows based on erroneous sub-basin delineation and land use conditions being reported in the Drainage Report[11], the storm inlet capacity for the culvert has been substantially increased. Stormflows are now conveyed to the storm inlets, and hence onto the property, much more rapidly than prior to the Boones Ferry Road widening project. This problem will worsen in the future because the Drainage Report and construction design did not take into account the future effects of full build-out conditions.

Flooding problems at the Lucini property are additionally aggravated because existing and future development conditions were disregarded in the Drainage Report. As CWS 2007 standards require:[12]

> 5.05 Storm Conveyance Design Considerations
>
> 5.05.1 Design for Full Build Out
>
> Storm drainage facilities shall be designed and constructed to accommodate all future full build-out flows generated from upstream property.

The Drainage Report did not evaluate the full build out stormflow conditions that will affect the property. Increased discharges from future development, routed through the County's road culvert, will result in worse flooding than presently exists.

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[10] CWS 2007, see Chapter 2, Page 12 under the 2.04.2 subsection heading "3. Review of Downstream System", i.e., this is subsection 2.04.2.3.

[11] See Drainage Report on Page 11, Table under heading 5.5 - Hydrologic Analysis Results. Specifically, see the table results for Discharge Location 15L that indicates a reduction in stormflows.

[12] CWS 2007, Chapter 5, Page7, see 1st paragraph in section 5.05.

3. Drainage Boundaries and Hydrologic Modeling

An evaluation of the stormflow drainage above the Lucini property establishes that the County's delineation of subbasin boundaries is crucially inaccurate. As broken down numerically in Table 1 for ORIGINAL conditions, the south section area of the County's Subbasin 17S is erroneously depicted as draining to the Lucini property. The south section is labeled Subbasin 17Sa in Table 1 below.

The faulty subbasin delineations in the County's Drainage Report (2013) are illustrated in Figures 4 and 5. The ORIGINAL drawings in the County's report were digitized by LEA into the computer aided design software, AutoCAD. This allowed for the making of the scale model to evaluate the subbasins affecting the Lucini property. Conversion of subbasin area into HEC-HMS compatible units in square-miles (mi^2) was also performed. The County's errors in its stated original runoff areas, draining to the Lucini property, overestimate the original stormflows that the property can convey.

Table 1. Land Area Inputs for Subbasins above the Lucini Property

For ORIGINAL and IMPLEMENTED Subbasin Boundaries

		Original Drainage Areas			
	Washington County Subbasin ID	Scale Model AutoCAD in^2	HEC-HMS Input mi^2	Subbasin Size ft^2	Subbasin Size acres
Corrected South Section	17Sa	9117253	0.002267	63314	1.45
Corrected North Section	17Sb+c	27264059	0.006781	189334	4.35
Original County Total	17S	36381312	0.009048	252648	**5.8**
Corrected South Section	17Sa	9117253	0.002267	63314	1.45
Central-Section	17Sb	7464200	0.001856	51835	1.19
North-Section	17Sc	19799859	0.004924	137499	3.16
Original County Total (OK, check on total above)	17S	36381312	0.009048	252648	**5.8**
		Implemented Drainage Areas			
	Washington County Subbasin ID	Scale Model AutoCAD in^2	HEC-HMS Input mi^2	Subbasin Size ft^2	Subbasin Size acres
South-Section	59Sa	7999004	0.001989	55549	1.28
North-Section	59Sb	23991460	0.005967	166607	3.82
Implemented County Total	59S	31990464	0.007956	222156	**5.1**

This resulted in erroneously concluding that the Boones Ferry Road right-of-way to the south of the original culvert[13] flowed into the Lucini property. The actual Original subbasin excluded all of the rainfall runoff from the southern strip of the County's wrongly depicted subbasin. This condition is illustrated in Figure 5, which more accurately shows the ORIGINAL stormflow from the southern strip as being routed to the Greenhill Lane subbasin.[14]

Original and Implemented Stormflows
Table 2 compares realistic ORIGINAL stormflows, as determined in this analysis, to the County's erroneous stormflows based on faulty subbasin drainage boundaries. For Original peak storm flows, it is estimated that the increased drainage area depicted in the County's Drainage Report results in a storm flow increase of about 31.5 percent that is discharged to the Lucini property. The hydrologic model inputs and results for HEC-HMS realistic Original conditions are contained in Appendix H.

Table 2. ORIGINAL Peak Stormflows
County Values Compared to HEC-HMS

Percent Increases for Projected County versus Actual Drainage Area Conditions

	Washington County Flows Based on Boones Fy. Road Drainage Analysis (cfs)	**HEC-HMS Flows Based on Actua1 BFR Drainage Areas** (cfs)	**Increase of Storm Flows to Lucini Property** (Percent)
Original Washington County - Pre-construction (prior to 2013)	1.17	0.89	31.5% [15]
Original Wash. CO Land Area - Ongoing Land Use (LU)	*County did Not Consider*	1.71	92.1%
Original Wash. CO Land Area - Projected Full Build-out (BO)	*County did Not Consider*	2.85	220.2%

The County's Drainage Report did not consider on-going land use changes other than the existing farming and single dwelling 2-acre lots. When actual ongoing urbanization and more intense land use are considered, the increased stormflows to the Lucini property are projected to increase by about 92.1 percent.

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[13] This is the original 12-inch diameter concrete cylinder pipe (CCP) culvert, which is about 40-foot long, and identified as the County's Outfall #5.

[14] This is identified in the County's Drainage Report (2013) as Subbasin "17s". See the background image of Figure 4, which uses HexBox labels to identify subbasins.

[15] The calculation is: [(0.1.17 – 0.89) / 0.89] equals 0.315 or 31.5 percent.

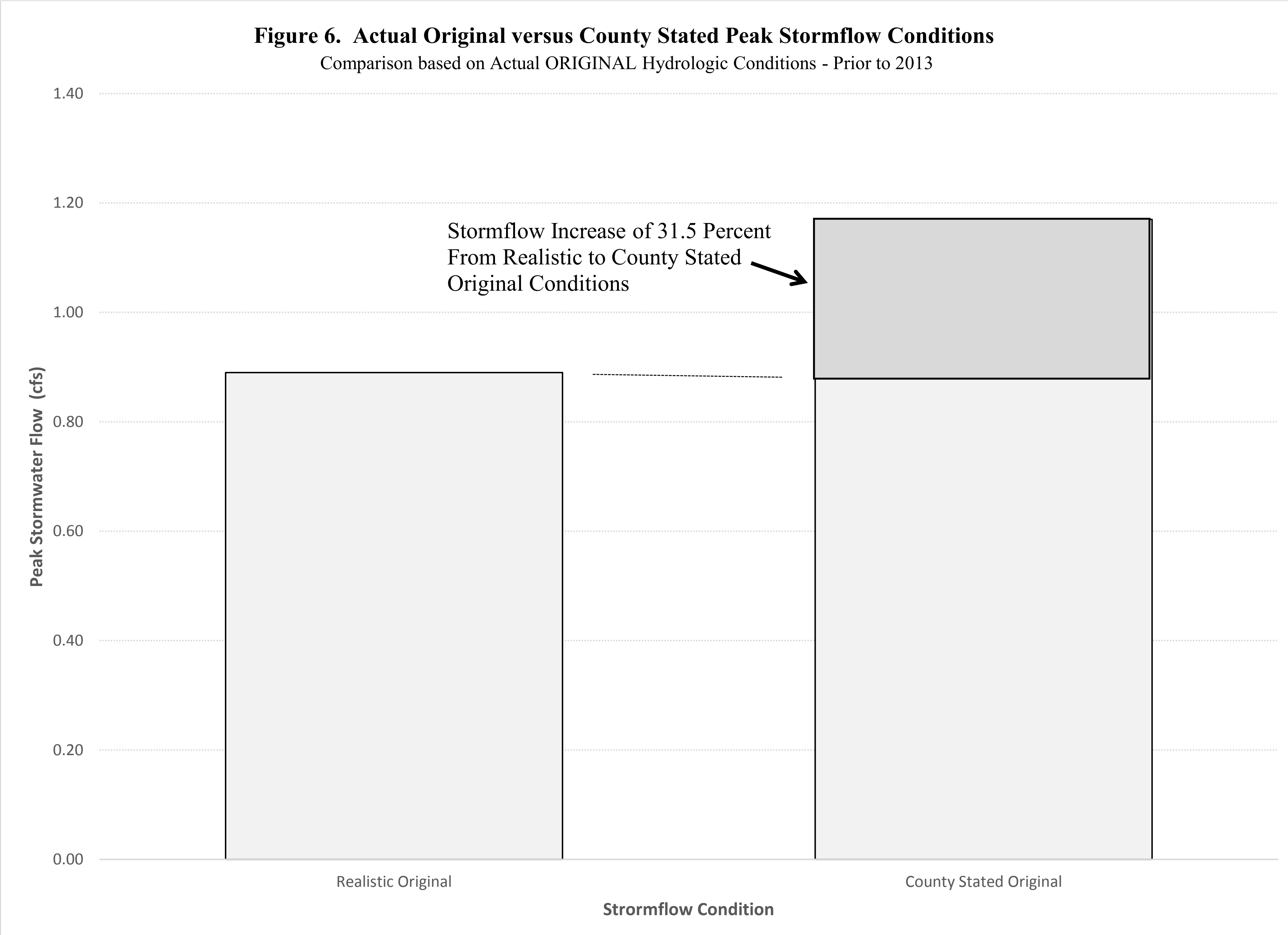
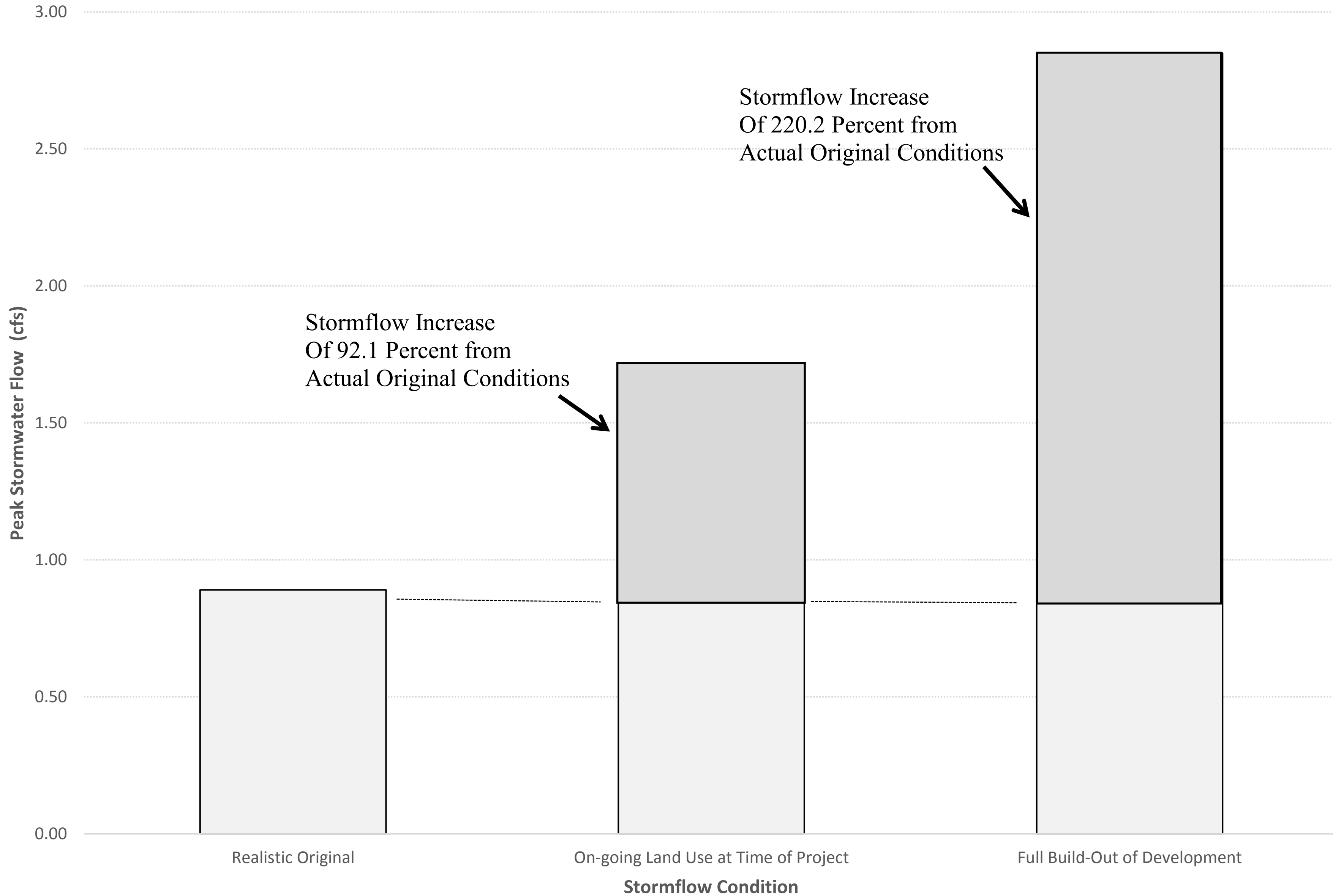


Figure 6. Actual Original versus County Stated Peak Stormflow Conditions
Comparison based on Actual ORIGINAL Hydrologic Conditions - Prior to 2013
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Peak Stormwater Flow (cfs)
Stormflow Increase of 31.5 Percent
From Realistic to County Stated
Original Conditions
Realistic Original
County Stated Original
Stormflow Condition

Figure 7. Increased Stormwater Peak Flows to the Lucini Property due to Ongoing Urban Land Use

Comparison based on Actual ORIGINAL Hydrologic Conditions - Prior to 2013



The County did not consider future full build-out construction conditions slated for the drainage above the Lucini property. When this necessary evaluation based on the CWS guidance is considered, the County will be increasing storm flows to the Lucini property by about 220.2 percent.

Table 3 compares IMPLEMENTED stormflows, as determined in this analysis, to the County's stormflows based on faulty subbasin drainage boundaries (see Figures 9 and 10). For the Implemented condition under previous land use, the LEA analysis and the County's analysis of peak flows are equal and no increase in flows is reported.

Table 3. IMPLEMENTED Peak Stormflows
County Values Compared to HEC-HMS

Percent Increases of Projected versus Actual Conditions

	Peak Storm Flow from HEC-HMS		
	Washington County Flows Based on Boones Fy. Road Drainage Analysis (cfs)	**HEC-HMS Flows Based on Actua1 BFR Drainage Areas** (cfs)	**Increase of Storm Flows to Lucini Property** (Percent)
Implemented Washington County - Post-construction (after about early 2015)	*County did not Consider* [16, 17]	0.64	32.8% [18]
Implemented Wash. CO Land Area - Ongoing Land Use (LU)	*County did Not Consider*	1.95	204.7%
Implemented Wash. CO Land Area - Projected Full Build-out (BO)	*County did Not Consider*	3.29	414.1%

The County's Drainage Report did not consider on-going land use changes. Only farming was evaluated. For Implemented peak storm flows, when on-going urbanization and more intense land use are considered, the increased storm flows to the Lucini property increase by about 204.7 percent.

The County did not consider future full build-out conditions construction scheduled for the drainage above the Lucini property. When this necessary evaluation based on the CWS guidance is considered, the County will be increasing storm flows to the Lucini property by about 414.1 percent.

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[16] The County simulated Implemented conditions that resulted in a stormflow of 0.85 cfs. The LEA hydrologic model was adjusted to the County's implemented conditions and stormflow of 0.85 cfs.

[17] Stormflows less than Original conditions were not considered by the County. The County claimed in its Drainage Report (2013) that it was reducing Original stormflows by about 10 percent.

[18] The calculation is (0.85 – 0.64) / 0.64 equals 0.328 or 32.8 percent. Where 0.85 cfs is the lowest velocity considered by Washington County.

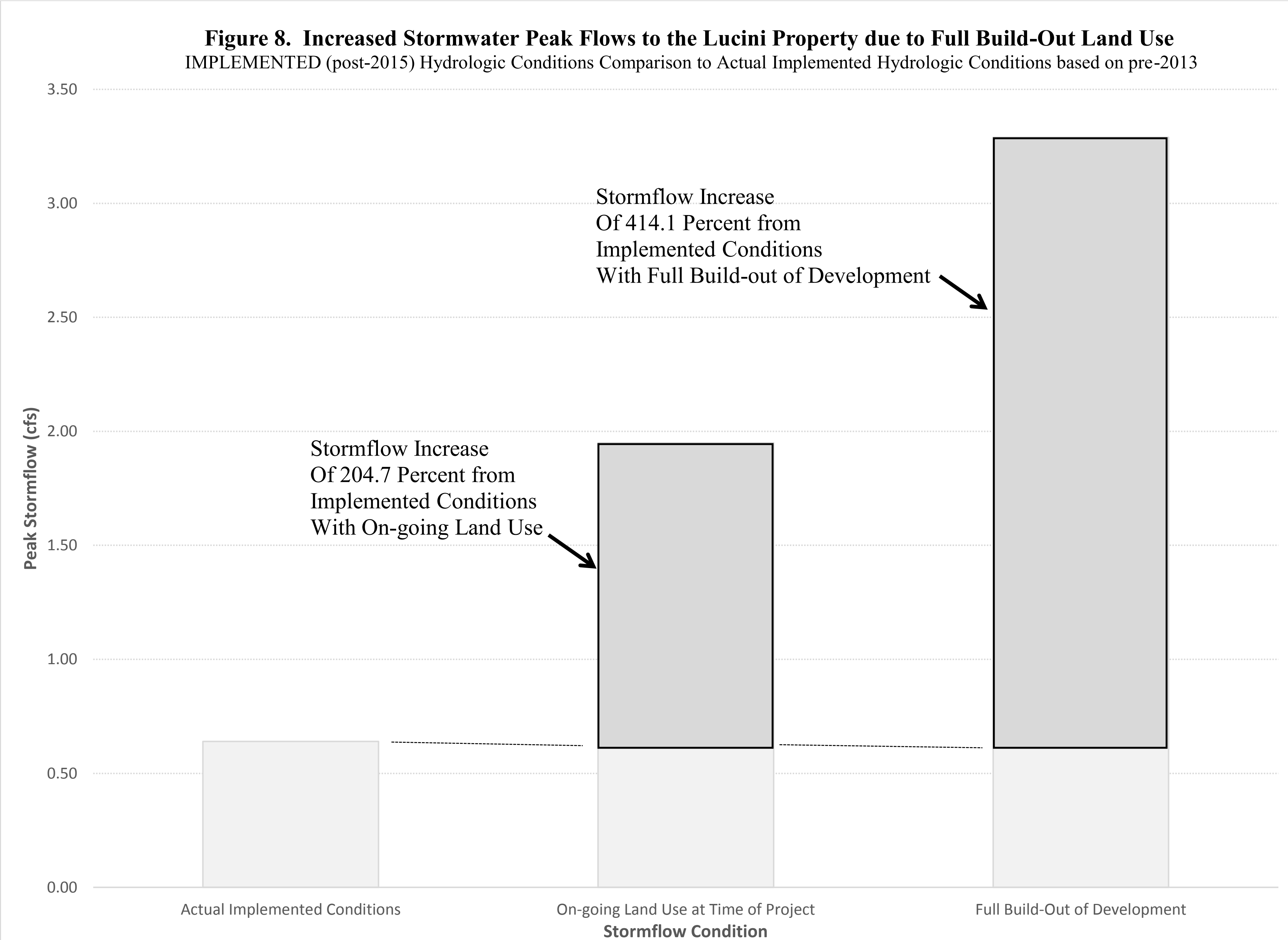
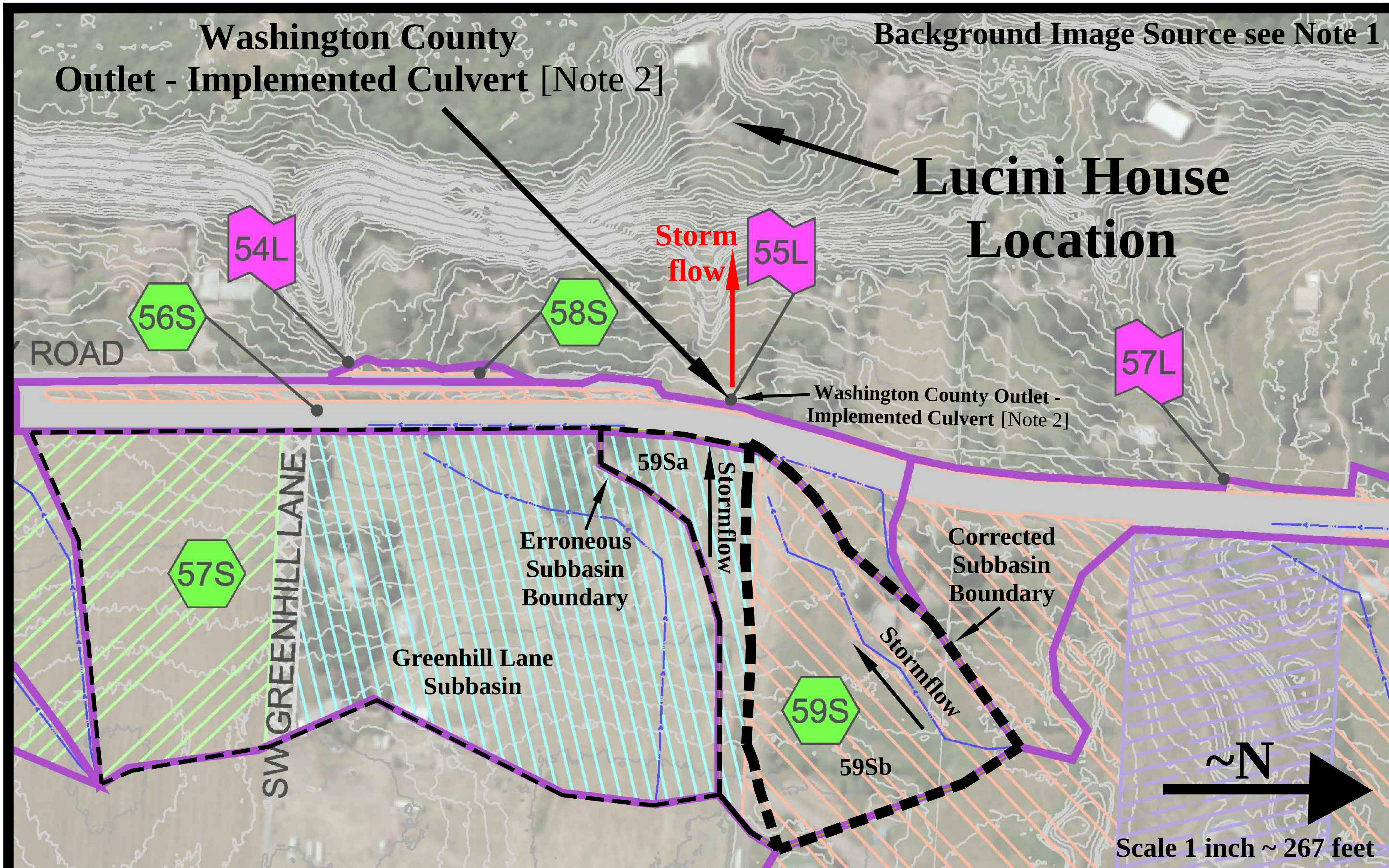


Figure 8. Increased Stormwater Peak Flows to the Lucini Property due to Full Build-Out Land Use
IMPLEMENTED (post-2015) Hydrologic Conditions Comparison to Actual Implemented Hydrologic Conditions based on pre-2013
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Peak Stormflow (cfs)
Stormflow Increase Of 414.1 Percent from Implemented Conditions With Full Build-out of Development
Stormflow Increase Of 204.7 Percent from Implemented Conditions With On-going Land Use
Actual Implemented Conditions
On-going Land Use at Time of Project
Full Build-Out of Development
Stormflow Condition

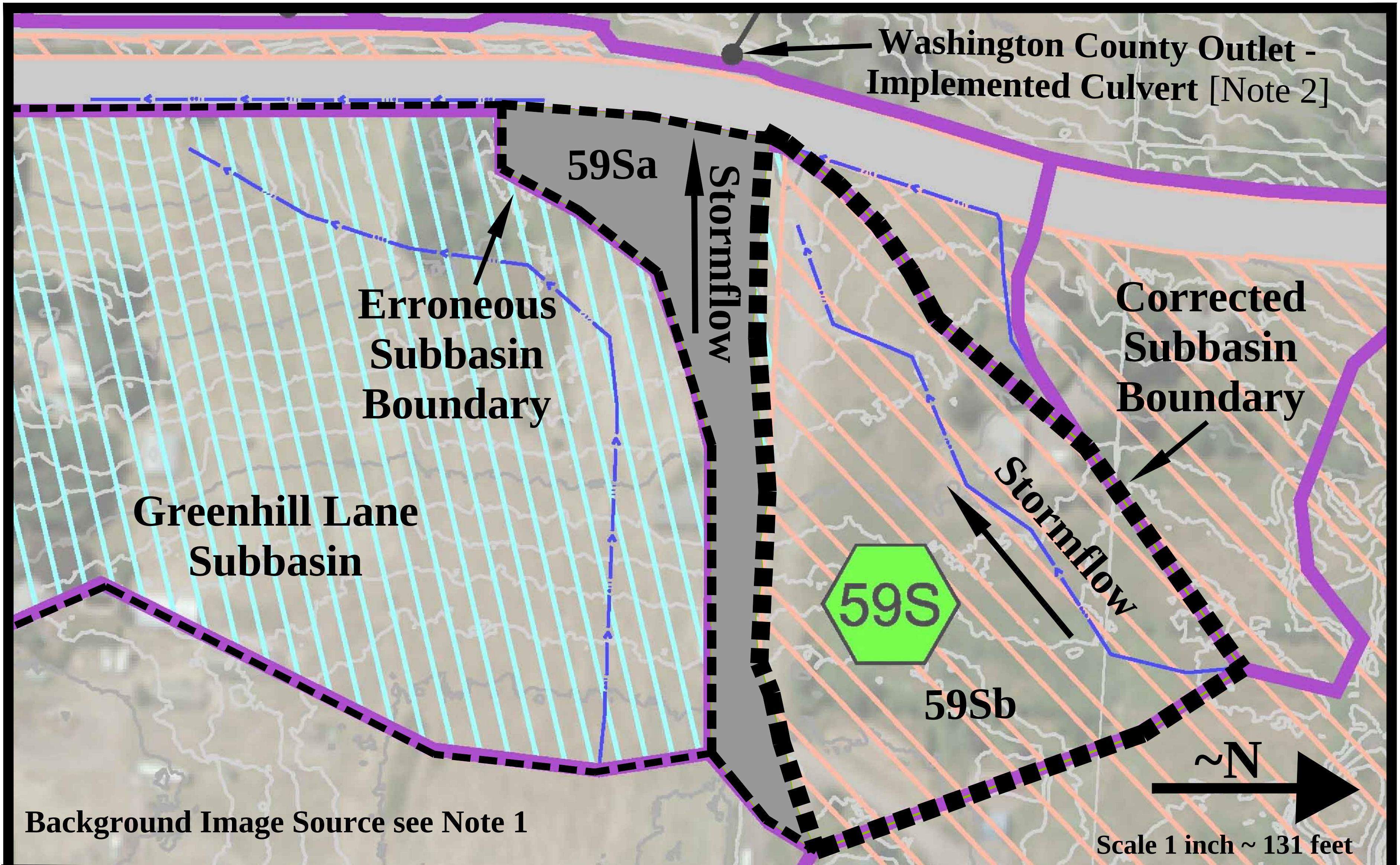


Notes:

[1] Background image source from Washington County *Storm Drainage Report* (January 2013), Existing Conditions Hydrology Map on PDF Page 36 of 152.

[2] Implemented Culvert, approximately 80-foot long, 12-inch Plastic (HDPE) discharging to the Lucini property. Overlayed from As-built construction plan drawings 232-233 of 385.

Figure 9. IMPLEMENTED County Subbasins - Erroneous Boundaries for Drainage above the Lucini Property.



Notes:
[1] Background image source from Washington County *Storm Drainage Report* (January 2013), Existing Conditions Hydrology Map on PDF Page 36 of 152.
[2] Implemented Culvert, approximately 80-foot long, 12-inch Plastic (HDPE) discharging to the Lucini property. Overlayed from As-built construction plan drawings 232-233 of 385.

Figure 10. IMPLEMENTED County Subbasins - Erroneous Boundaries for Drainage above the Lucini Property. (Close-in View)

Defective County Topography and Inaccurate Original Curb and Storm Sewer Claims
Stormflows originally directed south into the Greenhill Lane subbasin, through the road right-of-way, were re-routed by the road improvement project onto the Lucini property via the County's Storm Outfall #5. As shown in Figures 4 and 5, the subbasin drainage drawings for the ORIGINAL conditions[19] do not show the actual topography affecting drainage conditions. The IMPLEMENTED drainage basin conditions then re-route increased storm flows to the Lucini property.[20]

The County's Drainage Report says that the original road had curbs and storm sewers routing flows.[21] This is incorrect as there were no curbs or storm sewers for SW Boones Ferry Road above the Lucini property. Drawings 2C-7 and 2C-8 excerpted in Appendix C demonstrate there were no curbs and storm sewers upstream of the Lucini property.[22] Additionally, the photos in Appendix A1 taken by as part of the County's Wetland Delineation Report[23] and by the Lucini's also reveal the lack of curbs and storm sewers above the Lucini property. This is a crucial detail because it determines whether a portion of stormflows go south into the Greenhill Lane subbasin, or north into the subbasin above the Lucini property. In its Drainage Report the County erroneously claims that a portion of the Greenhill Lane subbasin stormwater drains into the Lucini property.

The photos contained in Appendix A1 show the ORIGINAL Drainage of Storm Water from SW Boones Ferry Road. Photo A1a was taken by Washington County September 28, 2012; and Photo A1b was taken by John & Grace Lucini on Dec. 20, 2012. Portions of the subbasins to the east (on the left) historically drained into the Road Alignment and then south away from the Lucini property. This is contrary to the analysis contained in the County's Drainage Report (2013), which wrongly states this road section is curbed including storm sewers, with portions of stormflows being directed into the Lucini property.

[19] Drainage Report (2013), Sheet No. 1 of 3 labeled "Existing Conditions Hydrology Map" on PDF page 35 of 152.

[20] Ibid, see Sheet No. 2 of 3 labeled "Proposed Conditions Hydrology Map" on PDF page 36 of 152.

[21] Drainage Report (2013), Storm Drainage Report – SW Boones Ferry Road (SW Day Road to SW Norwood Road, by MacKay Sposito for Washington County, Capital Project Management (CPM), Final January 31, 2013. See PDF page 59 of 152 under Summary of Subcatchment 17S, which is the drainage above the Lucini property. The Drainage Report erroneously states that the drainage is "w/curbs & sewers" which did not exist above the Lucini property. This faulty information and its implications were used in the County's hydrologic analysis.

[22] County 2012a, Drawings from MacKay Sposito submittal to the County contained in file: 2012 June Existing Conditions 70% Plans.pdf.

[23] County 2012b, See PDF page 81 of 90 in file: 2012 Dec Wetland Delineation Report-Boones Ferry Rd Improvement Project WD2013-0002.pdf.

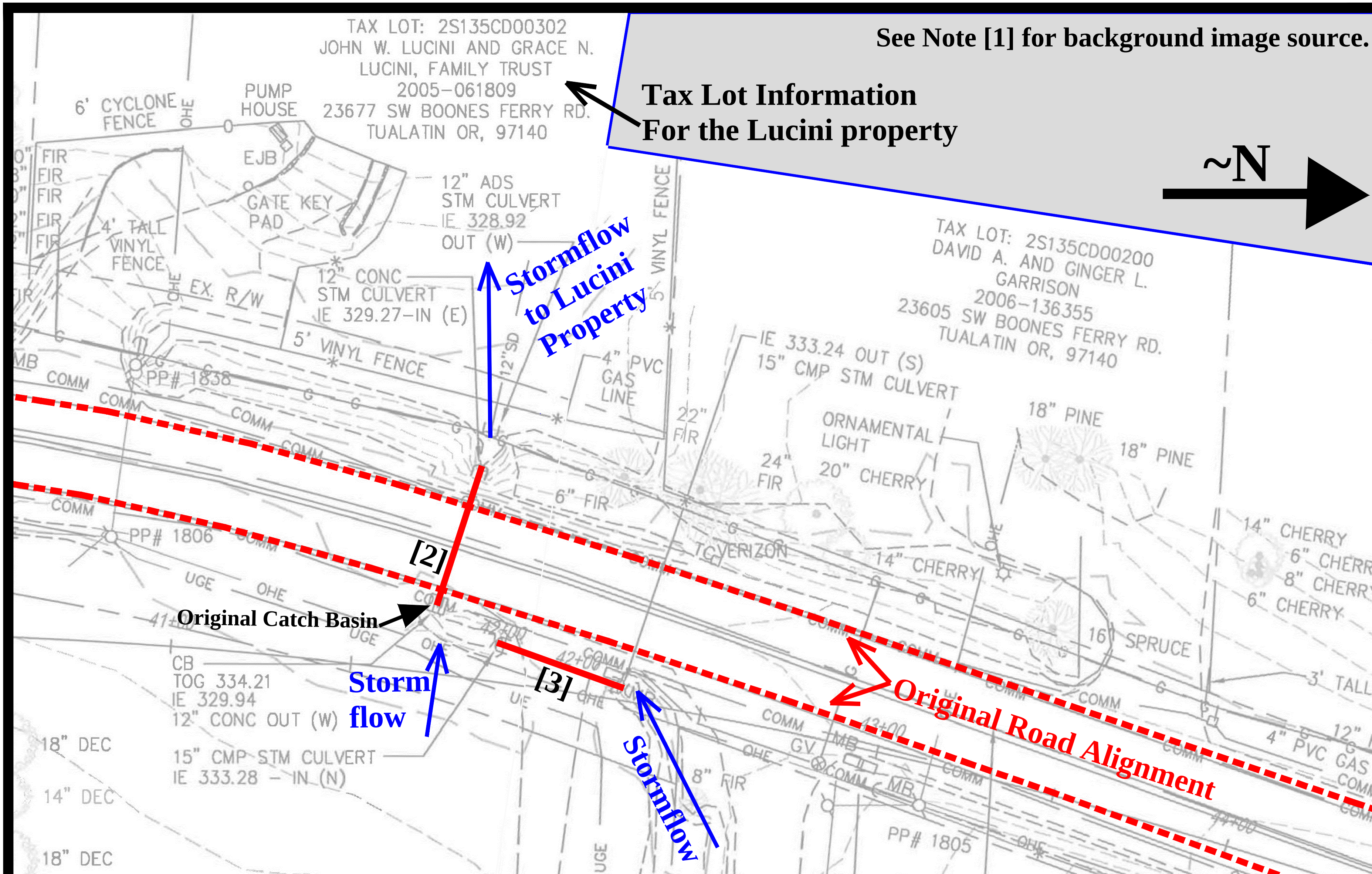


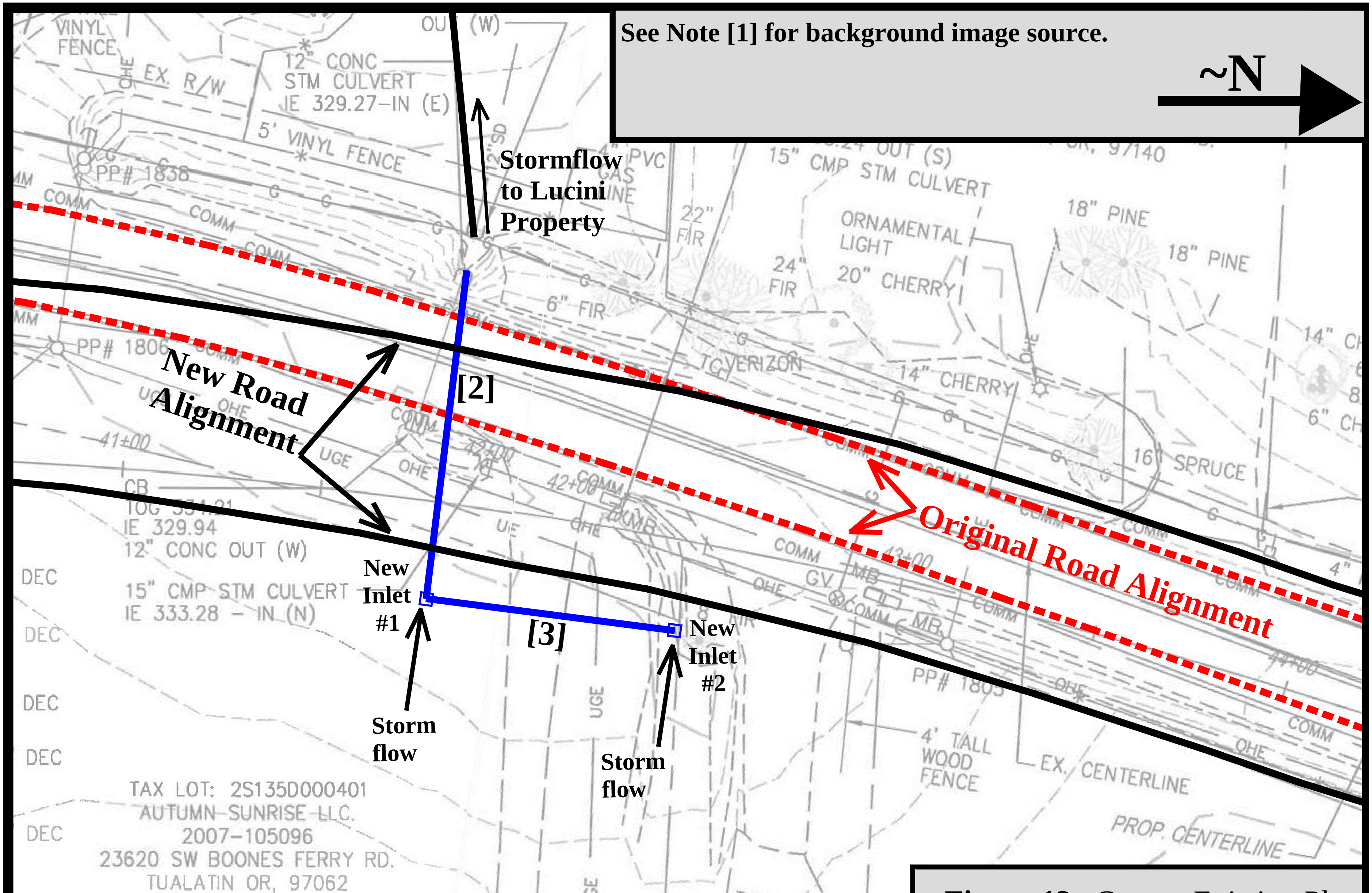
Figure 11. County Existing Plan Drawings with Annotations Highlighting the ORIGINAL Conditions and Piping

Notes:

[1] Background image from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

[3] Original Connecting Piping, about 42-foot long, 15-inch corregated metal pipe (CMP). Overlayed from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).



Notes:

[1] Background image from County Existing Conditions Plan drawings 2C-7 and 2C-8 (June 2012, 70 percent drawings).

[2] New Culvert, 80-foot long, 12-inch Plastic (HDPE) discharging to the Lucini property. Culvert and piping overlay from As-built construction plan drawings 232-233 of 385.

[3] Connecting Piping, 74-foot long, 12-inch Plastic (HDPE) piping, under two driveways. Connecting Pipe overlay from As-built construction plan drawings 232-235 of 385.

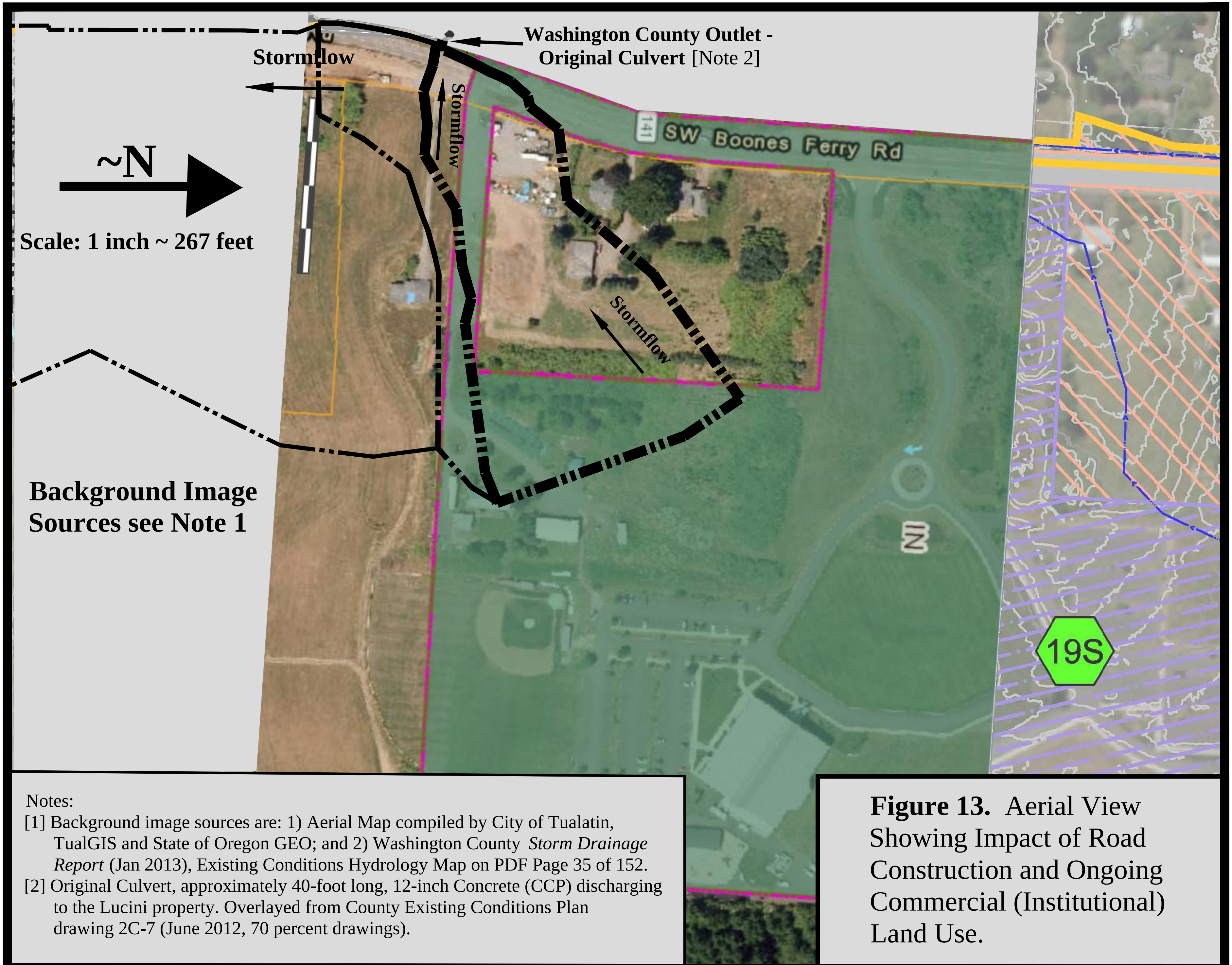
Figure 12. County Existing Plan Drawings with Annotations Highlighting the IMPLENTED Piping Conditions

Hydrologic Modeling and Construction Development

The County's Drainage Report disregarded construction development that increases run-off in the drainage upstream of the Lucini property. The County's hydrologic modeling of the upstream subbasin was characterized as "Farmstead" and single dwelling 2-acre lots. However, the actual additional use of a majority of the subbasin is to support heavy road construction and on-going use as commercial (Institutional), a more intense land-use from a stormwater generation standpoint. This relationship between the subbasin boundary delineation and active road construction (in 2012), equipment parking and material staging can be plainly seen in the aerial view presented in Figures 13 and 14.

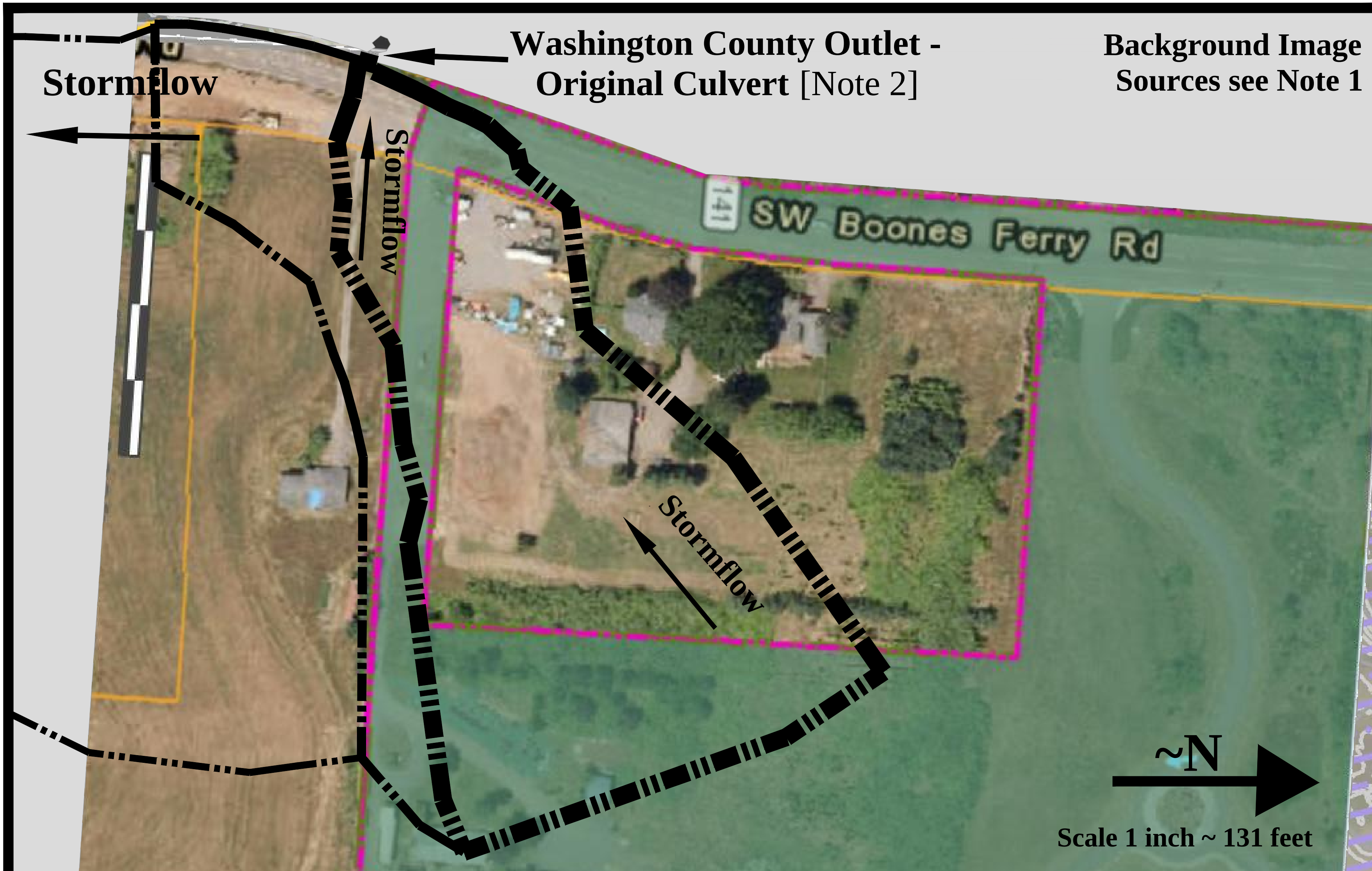
The Natural Resources Conservation Service (NRCS) has commented on this problem of disturbed soil effectively raising runoff flows and has stated:

> **630.0702 Disturbed soils**
>
> As a result of **construction and other disturbances**, the soil profile can be altered from its natural state and the listed group assignments generally no longer apply, nor can any supposition based on the natural soil be made that will accurately describe the **hydrologic properties of the disturbed soil**. In these circumstances, an onsite investigation should be made to determine the hydrologic soil group. A general set of guidelines for estimating **saturated hydraulic conductivity** from field observable characteristics is presented in the Soil Survey Manual (Soil Survey Staff 1993).
>
> [Bold by LEA except subsection title.]



Notes:
[1] Background image sources are: 1) Aerial Map compiled by City of Tualatin, TualGIS and State of Oregon GEO; and 2) Washington County *Storm Drainage Report* (Jan 2013), Existing Conditions Hydrology Map on PDF Page 35 of 152.
[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

Figure 13. Aerial View Showing Impact of Road Construction and Ongoing Commercial (Institutional) Land Use.



Notes:

[1] Background image sources are: 1) Aerial Map compiled by City of Tualatin, TualGIS and State of Oregon GEO; and 2) Washington County *Storm Drainage Report* (Jan 2013), Existing Conditions Hydrology Map on PDF Page 35 of 152.

[2] Original Culvert, approximately 40-foot long, 12-inch Concrete (CCP) discharging to the Lucini property. Overlayed from County Existing Conditions Plan drawing 2C-7 (June 2012, 70 percent drawings).

Figure 14. Aerial View Showing Impact of Road Construction and Ongoing Commercial (Institutional) Land Use. (Close-in View)

4. Stormflow Hydraulics

The County's Drainage Report did not perform a hydraulic analysis to assess the effects of its stormflow above and through the Lucini property. The Corps hydraulic model, HEC-RAS[24], is used in this analysis to partly[25] fill-in this crucial lack of stormflow hydraulic information.

Rainfall runoff flows generated by the hydrologic model HEC-HMS are supplied as inputs to the HEC-RAS hydraulic model to consider the impact on drainage channels, piping, and other features of the drainage system. Specifically, the hydraulic effects resulting from stormflows passing through the drainage system subbasins, stormflow routing, channels, culverts (piping), land use conditions, channel and piping materials, and other parameters can be assessed.

Cross-sections and Other Hydraulic Information

The HEC-RAS hydraulic model requires the input of cross-sectional information that demarcate the channel with elevation versus distance from the bank. Additional information supplied to the model includes distance between cross-sections, hydraulic losses and other stormflow parameters.

The County has not provided the public with complete topography of the subbasin draining to the Lucini property, and other properties, below its Boones Ferry Road project site. Accordingly, channel and pipe cross-section information are estimated for input into the HEC-RAS hydraulic model. Summary input and output hydraulic information for the HEC-RAS simulation is contained in Appendix I.

The County did not consider the hydraulic effects of increased stormflow conditions on the Lucini property resulting from its Boones Ferry Road Improvement construction project. As discussed previously, increased stormflows onto the Lucini project are likely because of inaccurate subbasin delineation by the County. The County also failed to consider the effects of ongoing and future development, with increasingly intense land use and full-build-out conditions, contributing to increased stormflows.

Hydraulic Analysis Results

The County did not consider stormflow cases that take into account greater land use conditions and future development above the Lucini property. For example, the County disregarded the impact of its own road construction efforts, plainly visible in the aerial views in Figures 13 and 14 as well as Appendix F, on lands draining to the Lucini property. The County characterizes these activities as "farming" or single dwelling 2-acre lots.

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[24] HEC-RAS refers to the River Analysis System hydraulic model developed by the Corps.

[25] This hydraulic analysis using HEC-RAS performs a steady-state evaluation for a range of peak stormflow conditions inputted from the HEC-HMS hydrologic model. A more detailed time-varying analysis employing unsteady stormflow conditions, with stormflow storage, may be warranted in future evaluation with additional planning information but is beyond the timing and scope of this report.

The analysis presented herein does take into account actual land use intensity and development circumstances as previously discussed in the Hydrologic Modeling section. This analysis evaluates conditions for both ORIGINAL and IMPLEMENTED hydraulic configurations for the range of runoff conditions presented in Tables 2 and 3, respectively. Appendix I contains the results of the hydraulic analysis.

Figure 15 depicts the hydraulic profile generated by HEC-RAS for the ORIGINAL configuration using runoff stormflows based on future full build-out development conditions at 2.85 cfs. Stormflow existing prior to the County's road project[26] (0.89 cfs) and additional profiles are also contained in Appendix I.

A key consideration in reviewing these figures is that the ground slope goes from moderate above (east) the Lucini property to very steep (west) on the Lucini property. The County's Drainage Report (2013) analysis did not consider this substantial change of slope and its likely effect, which is to cause high stormflow velocities and extremely erosive conditions, on the Lucini property.

Comparing velocities with likely stormflows demonstrates the value of reducing runoff flow peaks. High stormwater flows cause erosion and clog ditch and pipe locations. In this HEC-RAS analysis, 25-yr design storm events were varied by correcting for actual subbasin areas and using genuine land use conditions as described in the hydrologic Tables 2 and 3 of this report for the ORIGINAL and IMPLEMENTED configurations, respectively.

Figure 16 for the ORIGINAL configuration illustrates velocities for the upstream and downstream stations along the Lucini property approximate 150-foot ditch[27]. This figure shows that as stormflows increase from 0.89 cfs to 2.85 cfs, highly erosive storm velocities occur.

As charted in Figure 16, flow velocities in excess of 4.0 feet-per-second (fps) produce adverse conditions that erode soil.[28] This is consistent with the stormwater damage to the ditches, and pipe blockage, on the Lucini property (see photos in Appendix A2).

Figure 17 for the IMPLEMENTED configuration illustrates velocities for the upstream and downstream stations along the Lucini property approximate 150-foot ditch. This figure shows that as stormflows increase from 0.85 cfs to 3.29 cfs, highly erosive storm velocities will occur into the future.

The two lower flow conditions at 0.64 cfs and 0.85 cfs do not produce excessive storm velocities. The 0.64 cfs value is what the peak 25-year storm event should be if the County was actually reducing stormflows onto the Lucini property consistent with what it

[26] Prior to early 2013.

[27] This ditch is alongside the Lucini driveway and runs generally from east to west. See Figures 2 and 3 for the alignment of this drainage ditch relative to the County's road construction and the Lucini property.

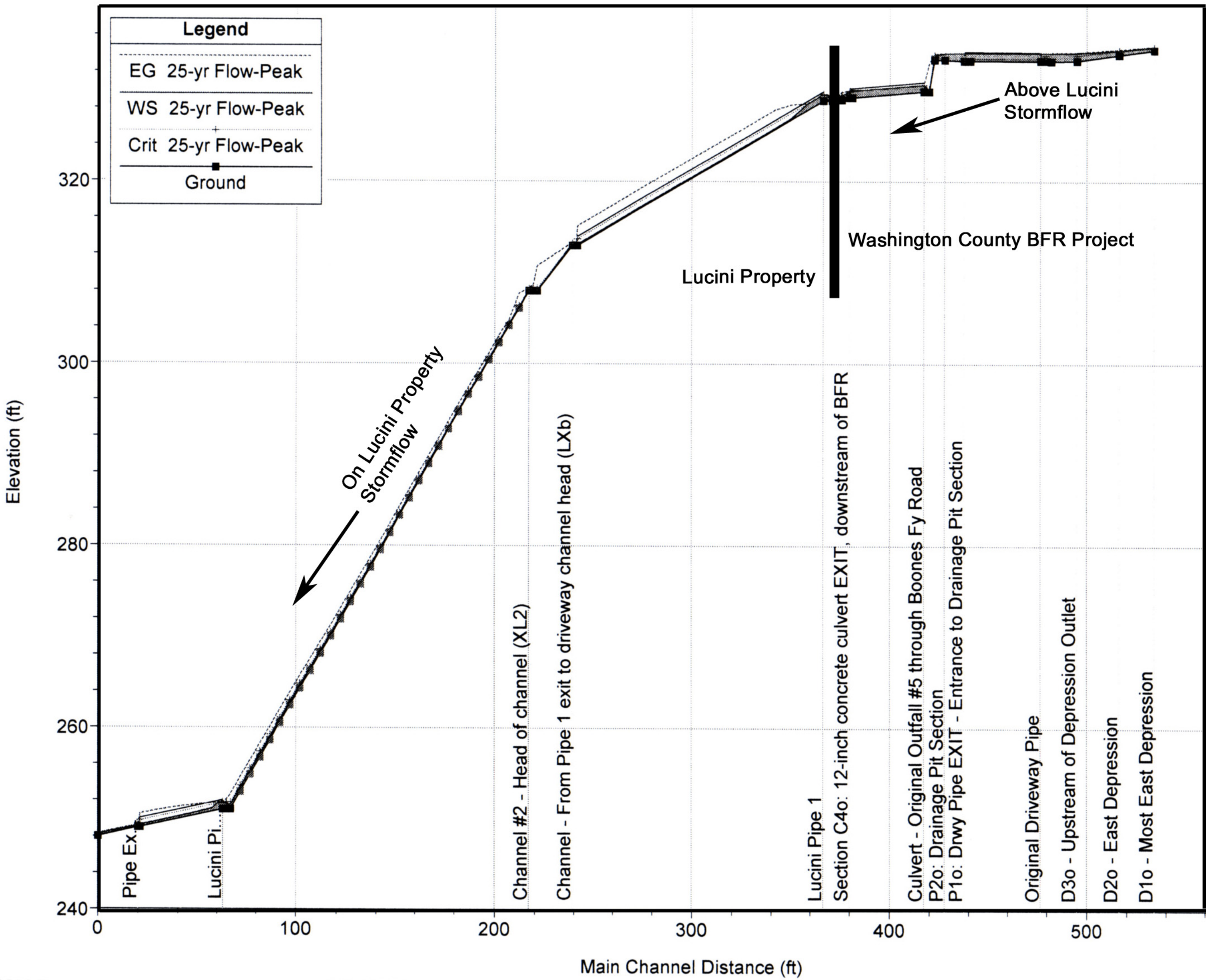
[28] Linsley, Ray K. and Franzini, Joseph B., Water-Resources Engineering, published by McGraw-Hill, 1979.

is saying in its Drainage Report. The 0.85 cfs value simulated by the County is for farmland only and does not include actual urbanization and increased runoff in the subbasin above the Lucini property. When actual ongoing land use is considered, stormflow of 1.95 cfs more accurately reflects actual runoff being discharged from the County's culvert (Outfall #5) onto the Lucini property.

An orifice plate can be used to reduce storm pipe flow diameter and flow area during peak flow events. This physical measure decreases peak stormflows and lowers storm flow velocities on the Lucini property. The location of the proposed orifice plate is shown in Figure 12 as indicated in the IMPLEMENTED new storm inlet #1.

The construction and installation plans for the orifice plate is shown in the guidance document relied upon by the County (CWS 2007). For convenience, the orifice plate drawings are presented in Appendix G (see CWA Drawings Nos. 720 and 730).

Figure 15. HEC_RAS Hydraulic Profile of ORIGINAL Pipe and Ditch Conditions at 2.85 cfs
Above and On the Lucini Property



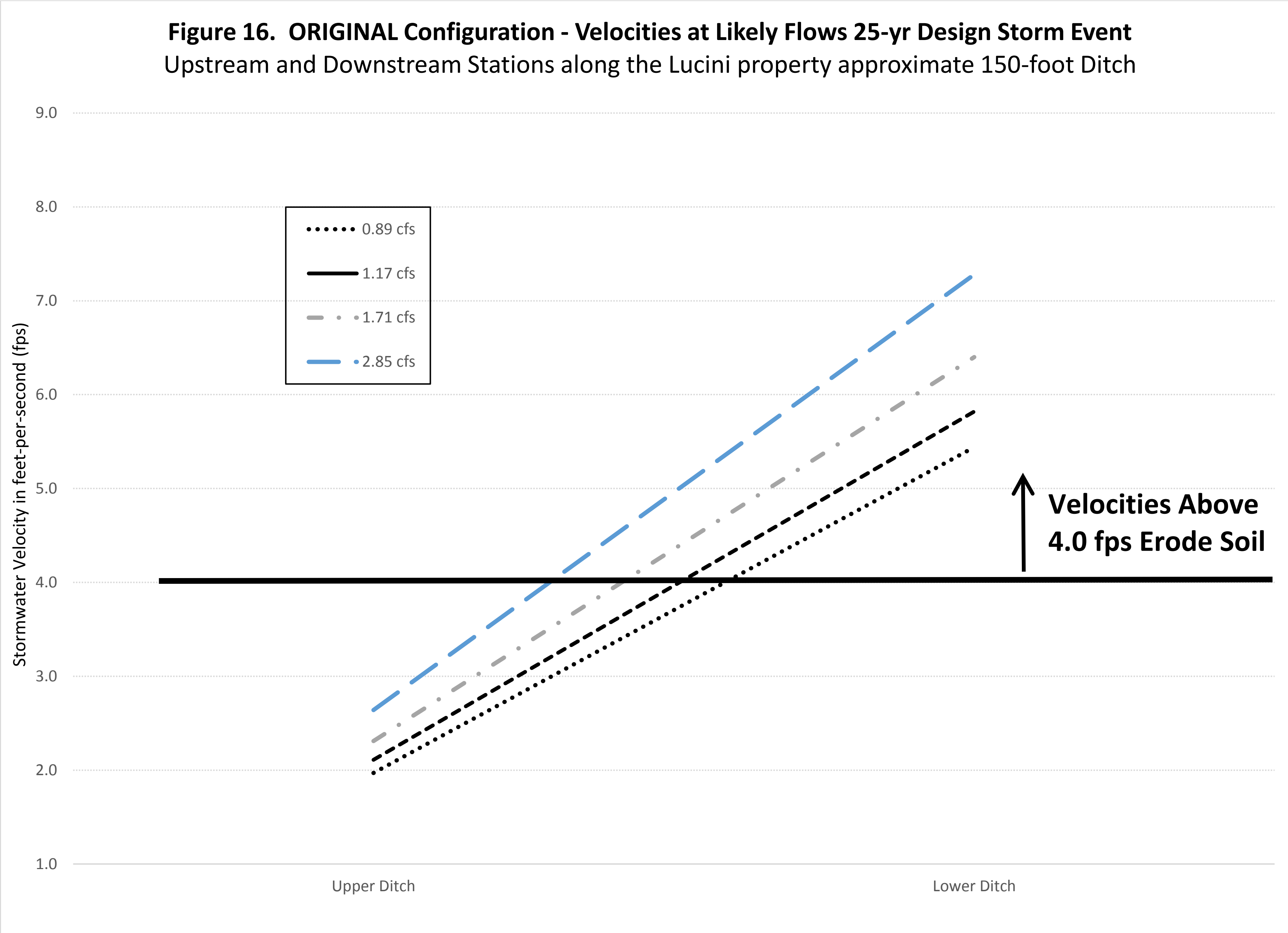


Figure 16. ORIGINAL Configuration - Velocities at Likely Flows 25-yr Design Storm Event
Upstream and Downstream Stations along the Lucini property approximate 150-foot Ditch
Stormwater Velocity in feet-per-second (fps)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.89 cfs
1.17 cfs
1.71 cfs
2.85 cfs
Velocities Above
4.0 fps Erode Soil
Upper Ditch
Lower Ditch

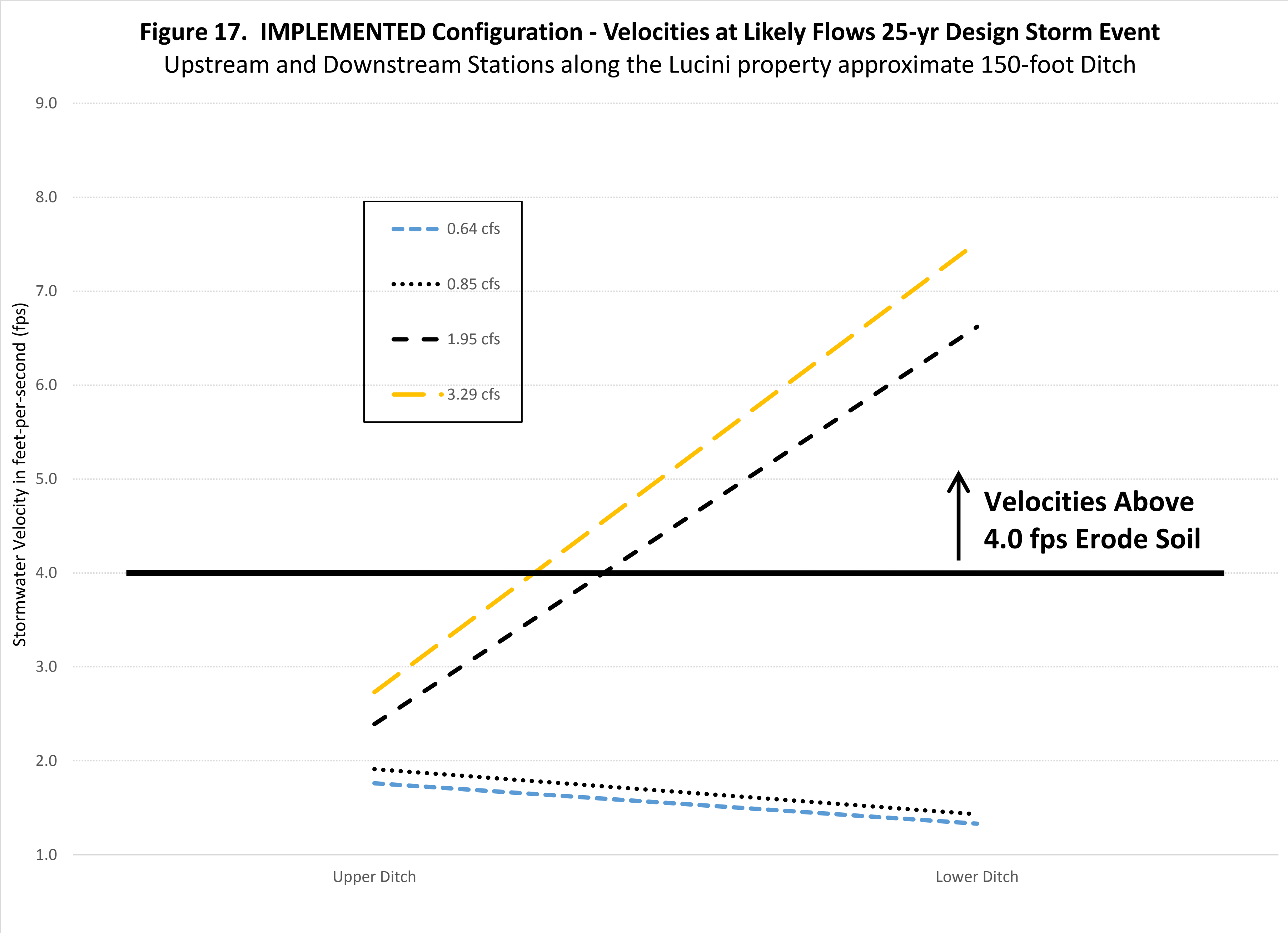


Figure 17. IMPLEMENTED Configuration - Velocities at Likely Flows 25-yr Design Storm Event
Upstream and Downstream Stations along the Lucini property approximate 150-foot Ditch
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
Stormwater Velocity in feet-per-second (fps)
0.64 cfs
0.85 cfs
1.95 cfs
3.29 cfs
Velocities Above
4.0 fps Erode Soil
Upper Ditch
Lower Ditch

5. Planning Level Costs

There are three levels of estimated capital costs associated with fixing problems on the Lucini property resulting from the County's SW Boones Ferry Road project:

1) Immediate Shorter Term Remedy using Orifice Plate ($4,500 to $6,500 installed)
2) Ongoing Flow and Water Quality Control Facilities ($12,157 to $17,560 installed)
3) Longer Term Detention/Retention Facilities (to several hundred thousand dollars)

These capital costs include equipment, materials, labor, and construction contractor overhead and profit. Design, engineering and construction management costs are separately considered. An estimate of 20 percent of the final construction capital cost for this relatively small scale project is considered. For the high range estimates above, the design cost estimates are $1,300 for number 1 and $3,572 for number 2.

These are planning level capital costs and are presented in a range between the lower cost that is 10 percent below the estimated base cost; and the high cost that is 30 percent above the estimated base cost. Presenting only a single estimated base cost is not adequate for planning purposes and providing costs as a range is more convenient. Planning level costs for construction are presented using this cost range method because direct bid costs are not part of this study. While actual bid costs may come in lower (e.g., 10 percent), if actual potential bid costs are higher (e.g., up to 30 percent) then the outcome is undesirable if unaccounted for.

1) Immediate Shorter Term Remedy

This remedy alleviates the immediate problem on a short-term basis by reducing peak stormflows and consequent erosion on the Lucini property. This can be accomplished by using an orifice plate at the County's New Inlet #1 (this is the south inlet). The proposed orifice location is shown in Figure 12 at the New Inlet #1. The orifice would be installed at the upstream end of the implemented 80-foot long, 12-inch diameter culvert comprising the County's Outfall #5.

The County has indicated it is using CWS 2007 for guidance, which contains the Drawing No. 730 "Orifice Plate and Guide" that can be installed in New Inlet #1. For convenience, the CWS Drawing No. 730 is contained in Appendix G of this report. Orifice plate openings of 6, 8 and 10 inches can be fabricated and each used separately until it is determined which size best reduces peak flows and most efficiently uses storage in the IMPLEMENTED pipes, ditches and depressions.

The installed orifice fits into the new inlet without structural changes to the inlet. Construction materials are not extensive or expensive. Accordingly, the cost of installation of this immediate remedy is estimated in the range of $4,500 to $6,500.

2) Ongoing Flow and Water Quality Control Facilities

Estimated costs of the intermediate remedy facilities are listed in Table 4.[29] Both flow and water quality (WQ) control are needed because high stormflow velocities cause erosion upstream as well as on the Lucini property. Debris and sediment transport are a significant threat to the Lucini property because it clogs downstream piping and causes flooding. The County did not evaluate stormwater conveyance from its road project through the Lucini property. Increased amounts of runoff directed to the Lucini property, and its effects, were disregarded in the County's drainage assessment.

Table 4. Capital Costs of Ongoing Flow and Water Quality Control Facilities

Control Unit	**Base Cost**
Flow Control Manhole Installed to the East of BFR at the south New Inlet #1 location.	$8,046
Water Quality Manhole Installed to the West of BFR just above the Lucini property.	$5,462
Total Estimated Base Costs	**$13,800**
Estimation Range Between (-10% and +30%)	**$12,157** to **$17,560**

The County provided storm grates on its two new stormwater inlets in the subbasin above the Lucini property as shown in Figure 12. The County neglected to provide a storm grate for the pipe entrance to the Lucini property (see Figure 12). The Lucini property drainage receives stormwater passing through SW Boones Ferry Road culvert (Outfall #5). The County supposed that its generated stormflow will be conveyed successfully through the Lucini property. The Corps HEC-HMS and HEC-RAS demonstrate that this is not the case for the 25-year design storm cases presented in this analysis.

It is important to note that the Greenhill Lane subbasin, to the south of the Lucini property, has received flow and water quality control. The Greenhill Lane subbasin and the Lucini property both drain to the Basalt Creek wetlands. For the Greenhill Lane subbasin, which has dual outfalls the County used at least three (3) manholes to control

[29] Costs are based on *RS Means Building Construction Cost Data* (2010). Costs are adjusted for inflation based on the cost index as published by the Engineering News Review (ENR). In this case the index is set at 8800.66 for 2010 and 10337.05 for 2016. This is calculated as an inflation ratio of 1.175, i.e., an inflation rate of 17.5 percent from 2010 to 2016.

flow and a water quality manhole to control pollution. The subbasin draining to the Lucini property has no manholes to control flow nor a water quality manhole to control pollution including eroded sediment and debris.

While the Greenhill Lane subbasin typically will have greater stormflows, the necessity of controlling excess stormflows to the Lucini property is no less significant. This is especially true because the County performed no downstream system evaluation for hydraulic conditions on the Lucini property and has no basis for discharging excess flows to the Lucini property.

The County has indicated it is using CWS 2007 for guidance, which contains: Drawing No. 270 "Flow Control Structure Detail" that can be installed at the New Inlet #1 location; and Drawing No. 240 "Water Quality Manhole (Mechanical)" that can be installed just upstream of the Lucini property pipe entrance. For convenience, CWS Drawing Nos. 270 and 240 are contained in Appendix G of this report. See Figure 12 for the locations of these proposed flow and water quality control facilities.

3) Longer Term Detention/Retention Facility
Future full build-out development in the subbasin draining to the Lucini property was not considered by the County's Drainage Report (2013). This is surprising because the subbasin is zoned for future development (FD-20)[30] and includes Tualatin's Institutional (IN) development as characterized by the Horizon Community Church with its large buildings, extensive driveways, parking lots, and numerous support facilities. Ongoing development in the subbasin above the Lucini's, including the construction of the BFR widening project itself, demonstrate that the trend of more intense urban development is already underway and having an effect on the Lucini property.

As shown in the hydrologic and hydraulic evaluations in this report, ongoing urban development is already producing stormflows that exceed ORIGINAL conditions, by about 220 percent, that the Lucini property has historically been subjected to (see Figure 7). Urban development above the Lucini property, under full build-out conditions, pose a still greater threat. These stormflow projections exceed, by about 414 percent, the ORIGINAL stormflow conditions that the Lucini property has historically been subject to as depicted in Figure 8.

Stormflows with ongoing development and full build-out conditions draining to the Lucini property require substantial detention (flow control) and retention (WQ control) measures. These stormwater control units are absent from the Drainage Report (2013) and have not been considered by the County.

The design and detailed costing of detention/retention facilities is beyond the scope of this report but construction and land costs could be as high as several hundred thousand dollars.

[30] Washington County 20-year Future Development (FD-20), see PDF Page 33 of 152

Supplement B: Part 2 – Rpt Appendices

Included under separate cover because of size.

Appendices - *Effects of SW Boones Ferry Road Construction (2013-2015): Stormflow Analysis for the Lucini Property* (LEA, November 2016)

Appendices

Appendix A

Appendix A1

Photos of ORIGINAL SW Boones Ferry Road
Above and just south of the Lucini Property

Photos taken prior to BFR Road Widening Project of 2013. The County's photo was taken on September 28, 2012 and the Lucini's photo was taken on December 20, 2012.

Photo A1a. This photo is from the County's Wetland Delineation Report (December 2010, PDF Page 81 of 90), which indicates the view is: "Looking south at the north - central portion of the study area." The County identifies this photo as "Photo K" taken on September 28, 2012. The mailbox on the right (to the west) identifies the Lucini property at 23677 SW Boones Ferry Road. The approach sign indicates the Greenhill Lane entrance is ahead but it is not visible because of the vertical curve in the road. There are no curbs or storm sewers in this section of the Boones Ferry Road contrary to the County's Drainage Report (2013).

Photo A1b. Drainage from the ORIGINAL Boones Ferry Road (December 2012). Looking northerly with ponding on the eastern (right) portion of the road. The white fence line of the Lucini property can be seen in the distance in the upper left of the photo, i.e., looking to the northwest. There are no curbs or storm sewers in this section of the ORIGINAL Boones Ferry Road contrary to the claim made in the County's Drainage Report (January 2013).

Appendix A2

Photos taken by John and Grace Lucini on May 18, 2015.
Showing the Downstream System conveying stormflows from
the SW Boones Ferry Road widening project

Excessive storm flows on May 18, 2015 overwhelmed the Lucini property.

Photo A2a. Storm flood waters directed to the Lucini property from Boones Ferry Road (5-18-15).

Photo A2b. Channel conveying Boones Ferry Road drainage across the Lucini property (5-18-15).

Photo A2c. The junction for the ditch and driveway pipe are overwhelmed and flood waters drain into the front yard toward the house (5-18-15).

Photo A2d. Flooding storm water ultimately found its way onto the porch and steps of the house and into the lower driveway area (5-18-15).

Photo A2e. The front lawn drained its flood waters into the walkway and porch in front of the house.

Photo A2f. The front walkway steps drain into the lower driveway and garage area.

Photo A2g. Flooding stormwater ultimately found its way into the lower driveway and garage area.

Appendix A3

Photos of Ongoing Erosion on Lucini Property (taken August 19, 2016)

Photo A3a. This photo of the Lucini property ditch was taken on August 19, 2016 and looks generally northeast up the slope to the pipe end exiting from the County's road project. This photo shows the continuing effects of erosion with the ditch spreading east and west into the embankment where bare soil and tree roots are exposed. To slow flows the owner has placed riprap and concrete block in the ditch to reduce stormwater flow velocities that continue to erode the channel requiring ongoing repairs. This photo corresponds to the flood location in photo A2a of the previous Appendix A2, which shows high velocity storm flows into the Lucini property.

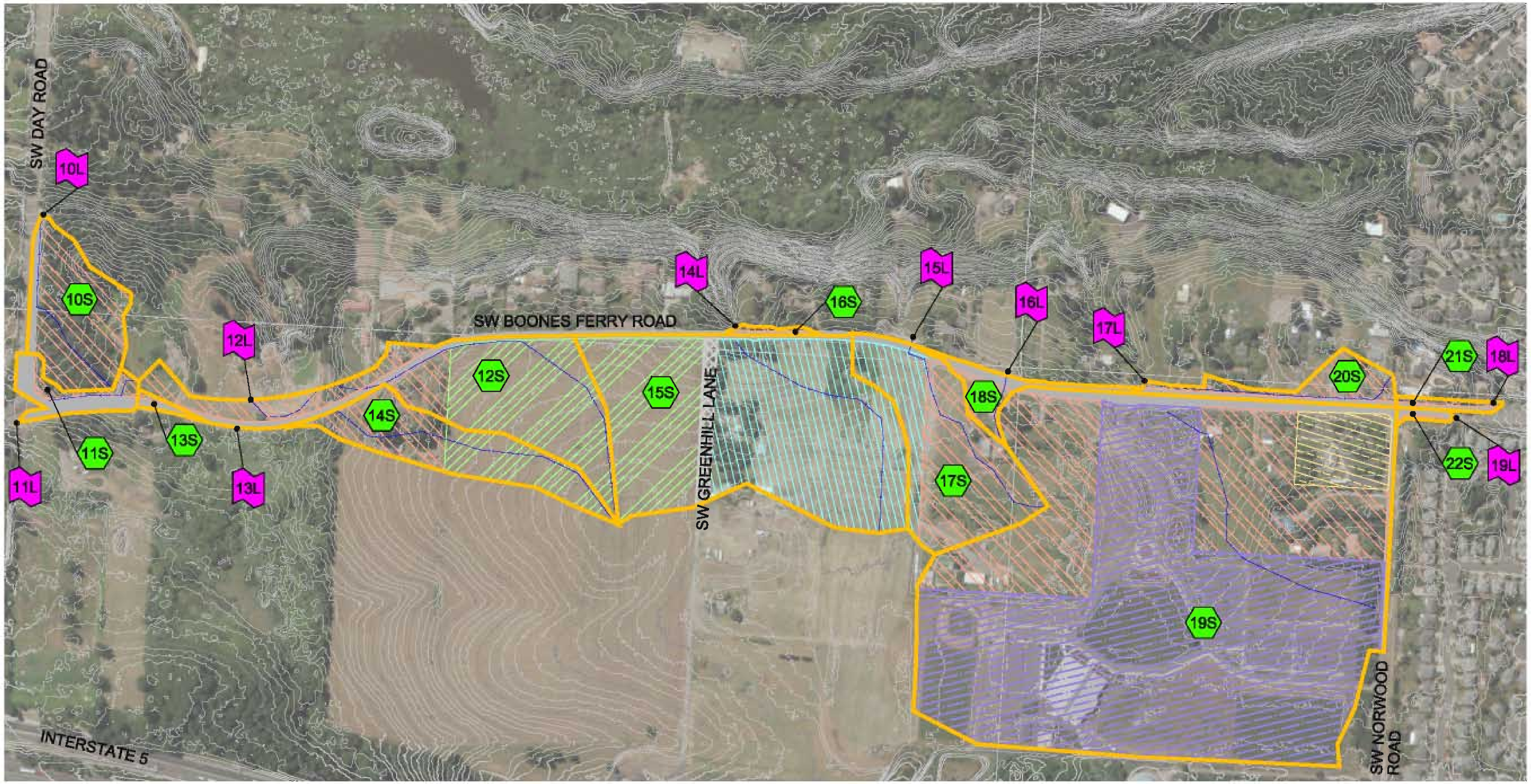
Photo A3b. This photo of the Lucini property ditch was taken on August 19, 2016 and looks generally east up the slope of the driveway. This photo shows the continuing effects of erosion with the ditch spreading south toward the driveway, and north into the embankment where bare soil and tree roots are exposed. To slow flows and reduce erosion, the owner has placed riprap in the ditch and gravel next to the driveway. However, very high stormwater velocities continue to erode the channel requiring ongoing repairs.

Photo A3c. This photo of the Lucini property ditch was taken on August 19, 2016 and looks generally northeast up the slope. This photo shows the continuing effects of erosion with the ditch spreading north into the embankment where bare soil and tree roots are exposed. To slow flows the owner has placed riprap in the ditch to reduce stormwater flow velocities that continue to erode the channel requiring ongoing repairs. This photo corresponds to the flood location in Photo A2c of the previous Appendix A2. The entrance to the 12-inch driveway culvert, which carries stormflows to the right (to the south), is hidden from view by the large rock at the bottom of the photo. See the next photo (A3d) for a view of the entrance to the driveway culvert).

Photo A3d. This photo of the westernmost base of the ditch was taken on August 19, 2016 and looks generally west toward the Lucini house. Shown the basin where stormwater collects and is routed into the entrance of the 12-inch corrugated plastic pipe (CPP), which is visible in the center of the photo. This pipe entrance allows flows to go south into the driveway culvert. Although a reversed view, this photo corresponds to the flood location in Photo A2c of the previous Appendix A2.

Appendix B

EXISTING CONDITIONS HYDROLOGY MAP



LEGEND

- *EXISTING CONDITION SUBBASIN BOUNDARY*
- *TIME OF CONCENTRATION FLOW LINE*
- 1S *SUBBASIN NODE*
- 1L *DISCHARGE LOCATION NODE*
- *LIDAR CONTOURS, 2' AND 10' (CITY OF WILSONVILLE)*

LAND USE (HYDROLOGIC MODEL)

- *PAVEMENT*
- *2-ACRE LOTS*
- *CHURCH*
- *CROPS*
- *FARMSTEAD*
- *GRAVEL*
- *SCHOOL*

N

0 400 800

SCALE: 1" = 400'

EXISTING CONDITIONS HYDROLOGY

DISCHARGE LOCATION	PRIMARY SITE CONVEYANCE	DOWNSTREAM RECEIVING ENTITY	CONTRIBUTING SUBBASINS
10L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF WILSONVILLE)	10S
11L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF WILSONVILLE)	11S
12L	MISC SURFACE FLOW	EXISTING DRAW, WEST	12S
13L	MISC SURFACE FLOW	EXISTING DRAW, SOUTHEAST	13S,14S
14L	CULVERT(S)	EXISTING RAVINE, WEST	15S, 16S
15L	CULVERT(S)	EXISTING PIPE CONVEYANCE, WEST	17S
16L	PAVEMENT RUNOFF	NON-POINT SHEET FLOW	18S
17L	CULVERT(S)	EXISTING CHANNEL, SOUTHWEST	19S, 20S
18L	MISC SURFACE FLOW	EXISTING ROADSIDE LOWPOINT, WEST	21S
19L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF TUALATIN)	22S

SW BOONES FERRY RD.

SW DAY ST. TO SW NORWOOD RD.

WASHINGTON COUNTY

HYDROLOGY MAPS

PLOT STAMP: 01/31/13 4:53A BTHAYNE

CAD: 15315_BFR_HYD.DWG, TAB: EX-ONSITE

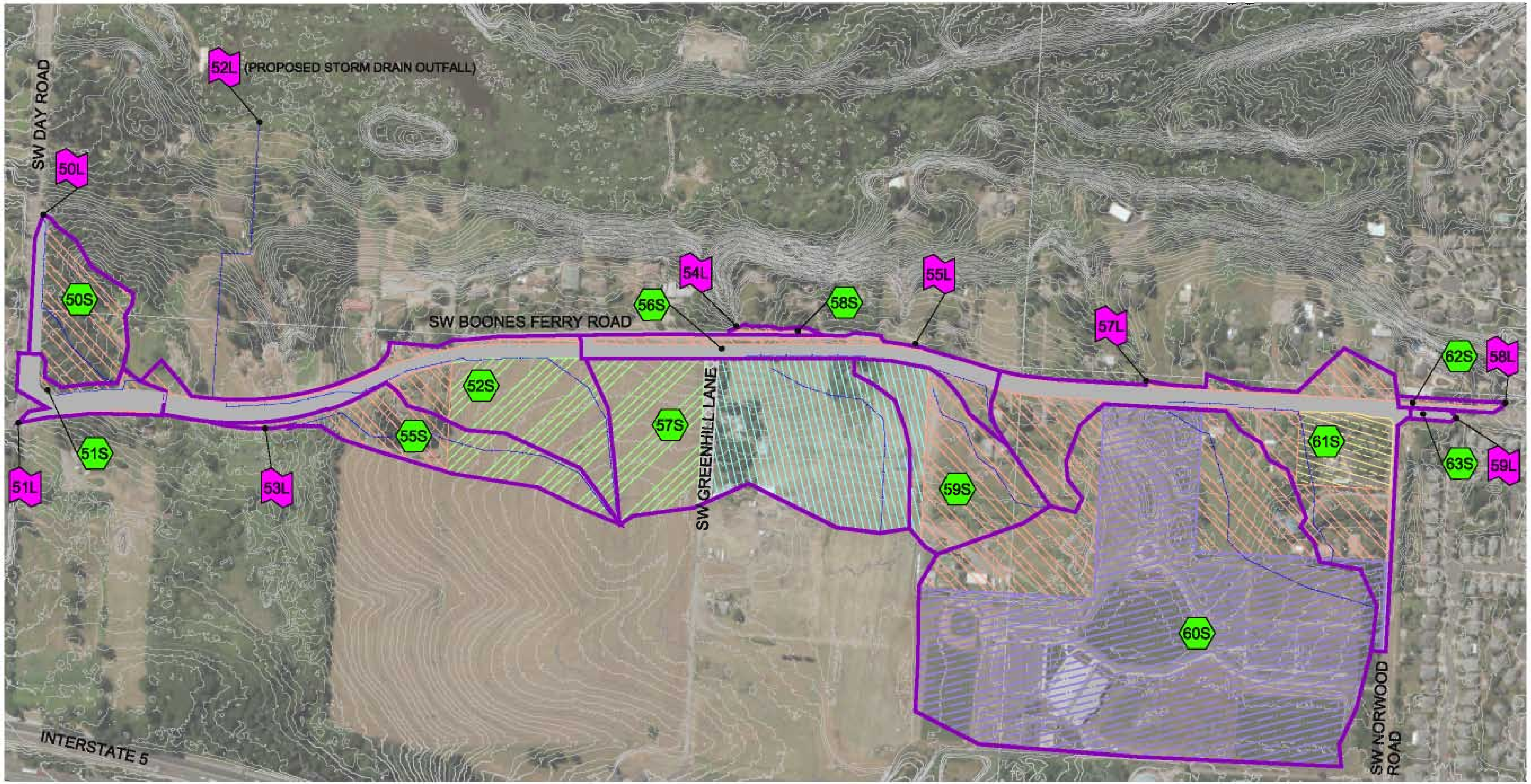
PATH: W:\15315\CIVIL\DWG\MISC\

PROJECT NUMBER 100096

SHEET NO. 1 OF 3

SHEET TITLE HYD1

PROPOSED CONDITIONS HYDROLOGY MAP



LEGEND

PROPOSED CONDITION SUBBASIN BOUNDARY

TIME OF CONCENTRATION FLOW LINE

1S SUBBASIN NODE

1L DISCHARGE LOCATION NODE

LIDAR CONTOURS, 2' AND 10' (CITY OF WILSONVILLE)

LAND USE (HYDROLOGIC MODEL)

PAVEMENT

2-ACRE LOTS

CHURCH

CROPS

FARMSTEAD

GRAVEL

SCHOOL

PROPOSED CONDITIONS HYDROLOGY

DISCHARGE LOCATION	PRIMARY SITE CONVEYANCE	DOWNSTREAM CONVEYANCE DESCRIPTION	CONTRIBUTING SUBBASINS
50L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF WILSONVILLE)	50S
51L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF WILSONVILLE)	51S
52L	PROPOSED STORM DRAIN	BASALT CREEK MARSH	52S
53L	MISC SURFACE FLOW	EXISTING DRAW, SOUTHEAST	55S
54L	PROPOSED STORM DRAIN	EXISTING RAVINE, WEST	56S, 57S, 58S
55L	CULVERT(S)	EXISTING PIPE CONVEYANCE, WEST	59S
56L	NOT USED	NON-POINT SHEET FLOW	NOT USED
57L	PROPOSED STORM DRAIN	EXISTING CHANNEL, SOUTHWEST	60S, 61S
58L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF TUALATIN)	62S
59L	GUTTER FLOW	EXISTING STORM DRAIN (CITY OF TUALATIN)	63S

N

0 400 800

SCALE: 1" = 400'

SW BOONES FERRY RD.
SW DAY ST. TO SW NORWOOD RD.
WASHINGTON COUNTY

HYDROLOGY MAPS

PLOT STAMP: 01/31/13 4:46A BTHAYNE
CAD: 15315_BFR_HYD.DWG, TAB: PRO-ONSITE
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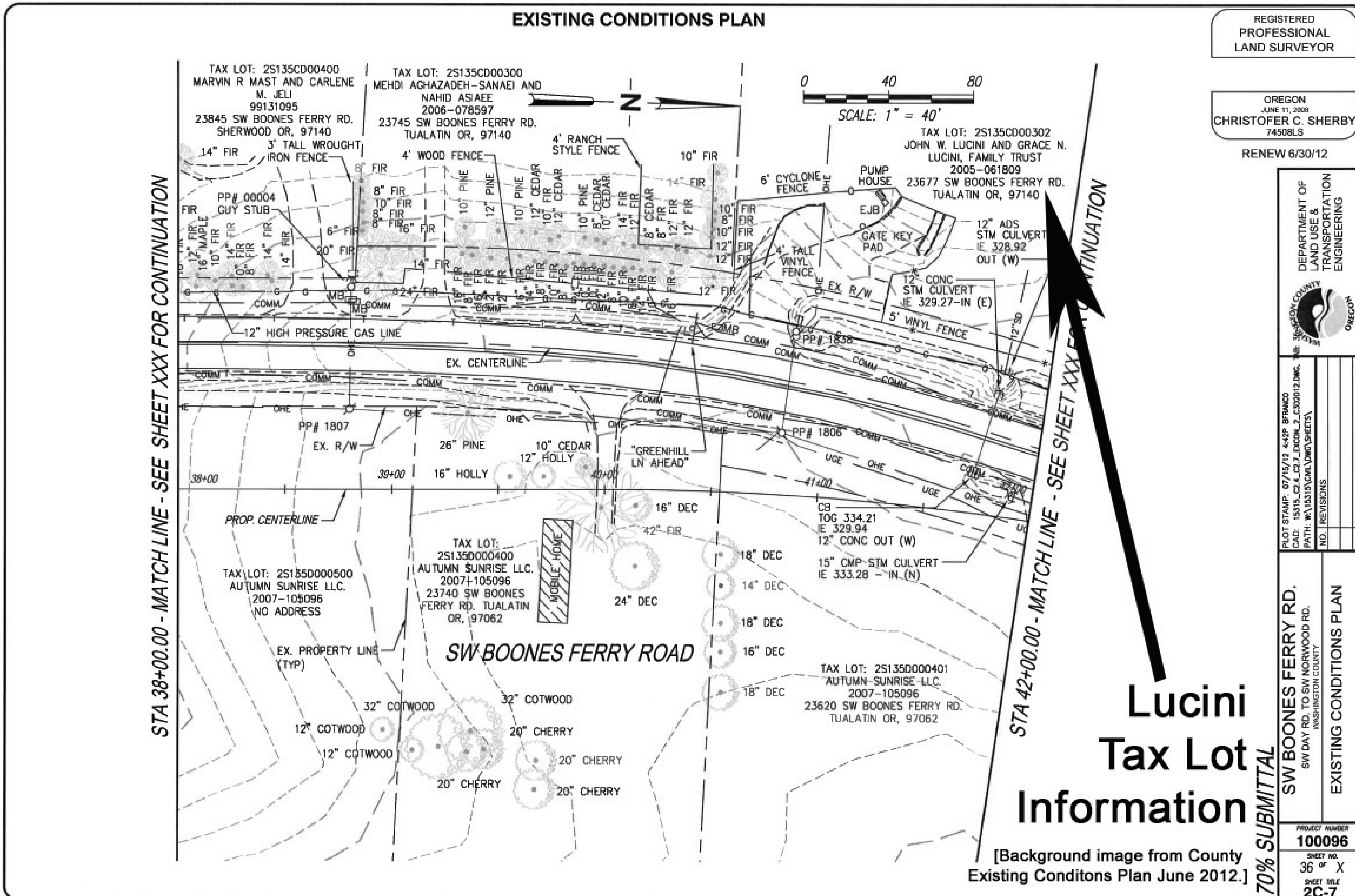
PROJECT NUMBER 100096

SHEET NO. 2 OF 3

SHEET TITLE HYD2

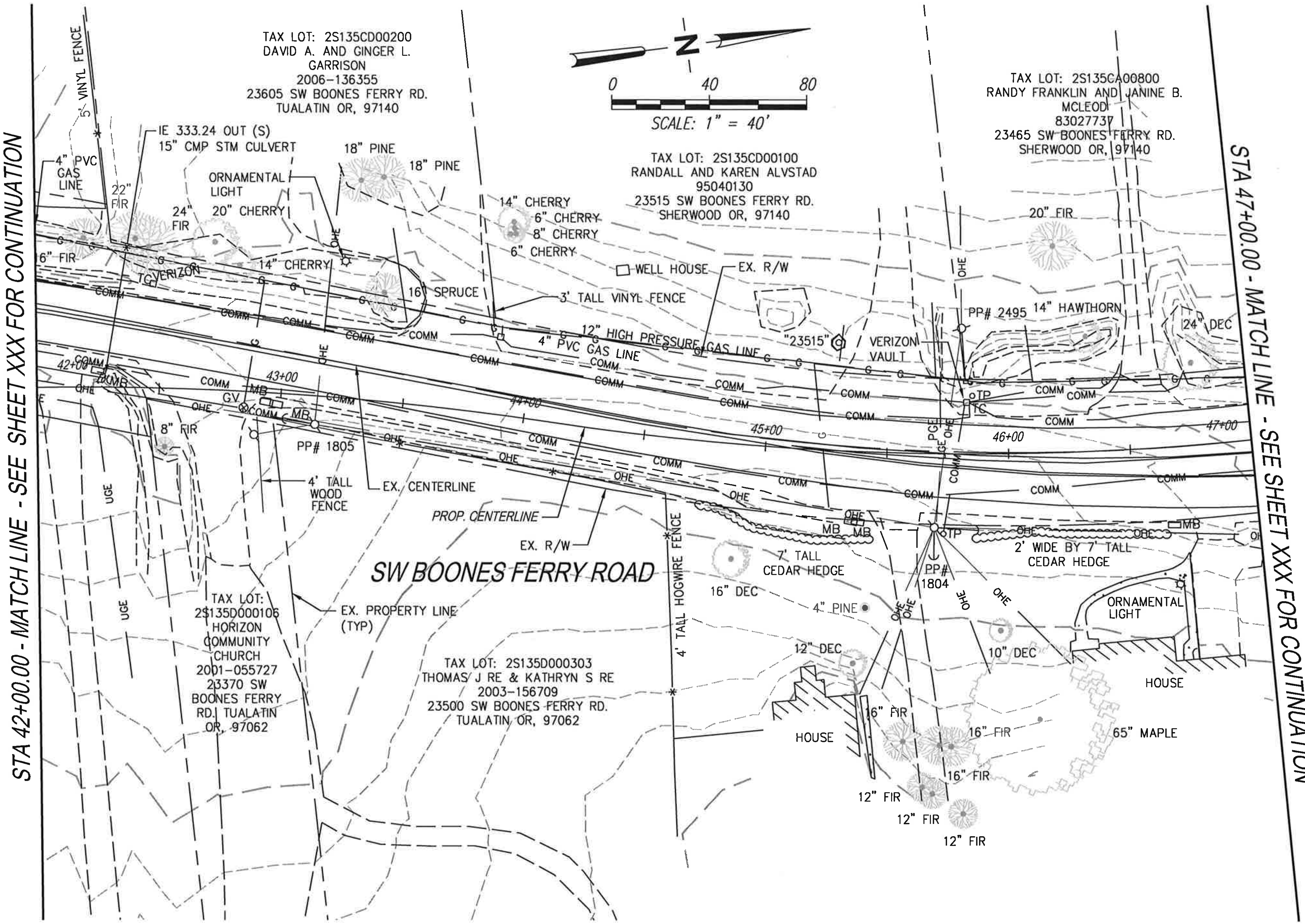
Appendix C



Lucini Tax Lot Information

[Background image from County Existing Conditons Plan June 2012.]

EXISTING CONDITIONS PLAN



REGISTERED PROFESSIONAL LAND SURVEYOR

OREGON
JUNE 11, 2008
CHRISTOFER C. SHERBY
74508LS

RENEW 6/30/12

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING

WASHINGTON COUNTY OREGON

PLOT STAMP: 07/15/12 4:42P BFRANCO
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NO.	REVISIONS

70% SUBMITTAL

SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

EXISTING CONDITIONS PLAN

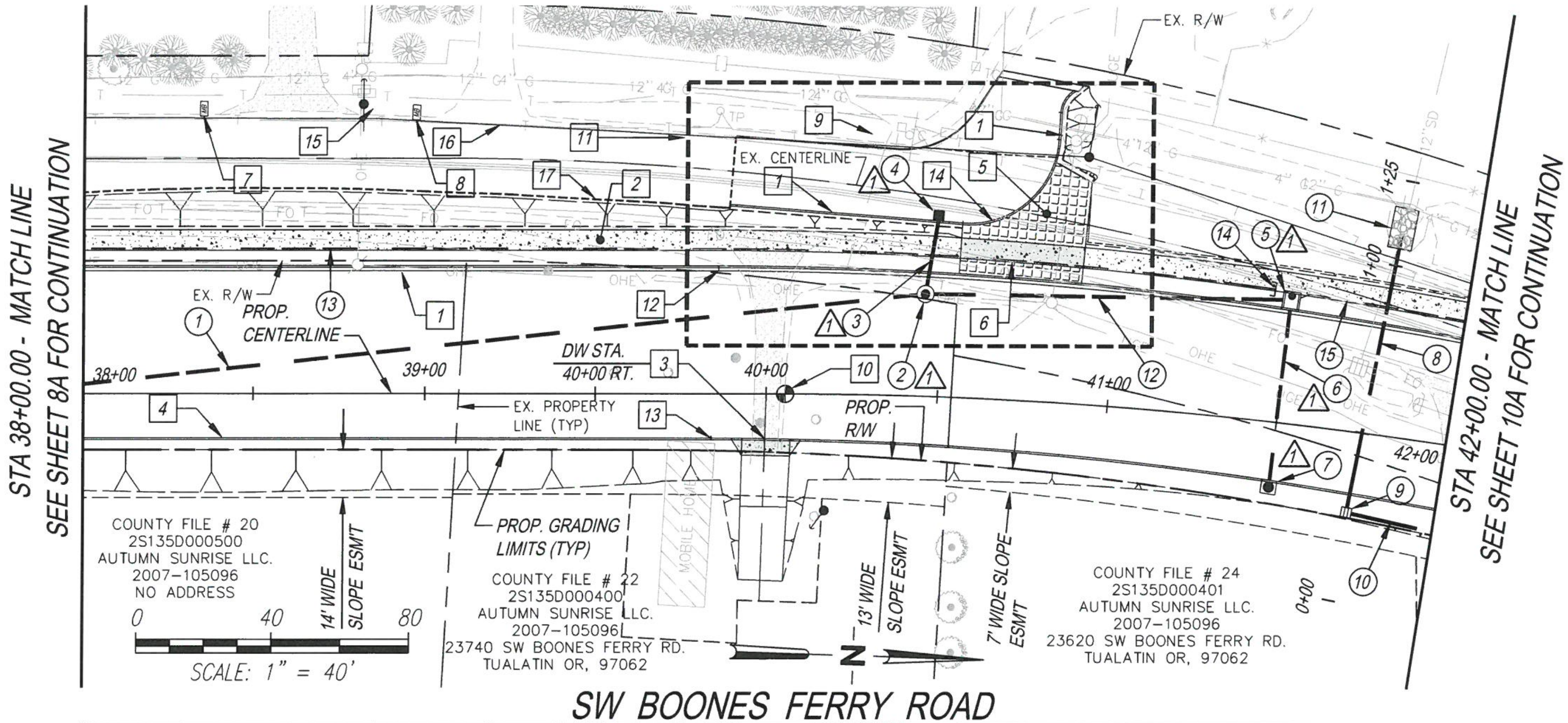
PROJECT NUMBER 100096

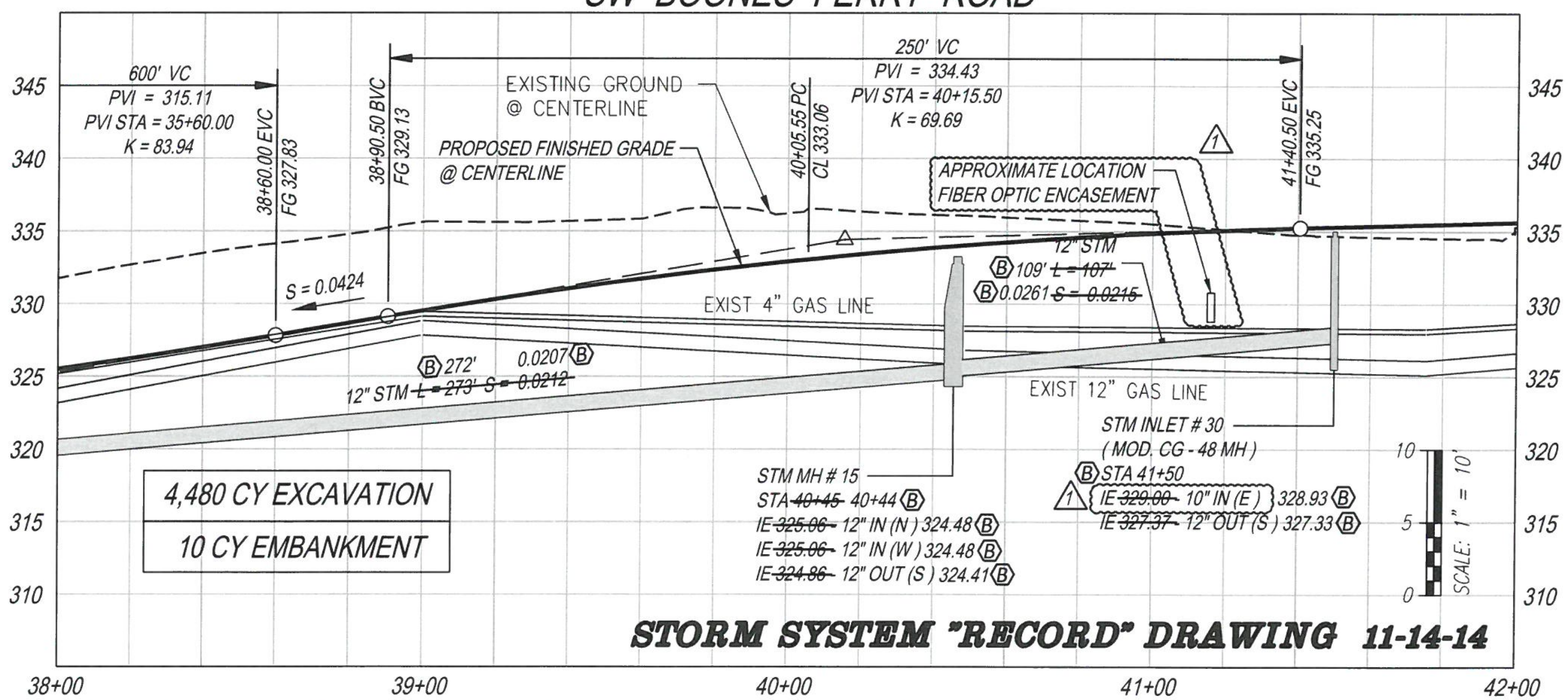
SHEET NO. 37 OF X

SHEET TITLE 2C-8

Appendix D

CONSTRUCTION PLAN AND PROFILE





STORM SYSTEM "RECORD" DRAWING 11-14-14

REGISTERED PROFESSIONAL ENGINEER 15552PE OREGON JULY 25, 1991 DAMON C. WEBSTER 11/18/14
EXPIRES: 6/30/16

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING
WASHINGTON COUNTY OREGON

PLOT STAMP: 11/17/14 7:47A ASTAICH
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NO.	REVISIONS	
1	REVISION NO. 3	5-20-2013 RRM
B	STORM SYSTEM "RECORD" DATA 11-14-14	

SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

CONSTRUCTION PLAN AND PROFILE

MacKay Sposito
ENERGY PUBLIC WORKS LAND DEVELOPMENT
www.mackaysposito.com

PROJECT NUMBER 100096
SHEET NO. 145 OF 274
SHEET TITLE 9A

CONSTRUCTION NOTES

THIS SHEET TO FACE SHT. 9A

1. CONST. P.C. CONC. CURB & GUTTER
   SEE SHEET 2B-4 FOR DETAILS
2. CONST. POROUS P.C. CONC. WALK
   SEE SHEET 2B-6 FOR DETAILS
3. CONST. P.C. RESIDENTIAL DRIVEWAY
   SEE SHEET 2B-1 & 2B-2 FOR DETAILS
4. CONST. P.C. CONC. MOUNTABLE VERTICAL CURB
   SEE SHEET 2B-4.1 FOR DETAILS
5. INSTALL UNIT PAVERS AS SPECIFIED IN BOOK 2
6. CONST. CONC. COMMERCIAL DRIVEWAY
   SEE SHEET 2B-6 FOR DETAILS
7. CONST. SINGLE MAILBOX
   STATION 38+35
   MB ADDRESS "23845"
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
8. CONST. SINGLE MAILBOX
   STATION 38+97
   MB ADDRESS "23745"
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
9. CONST. SINGLE MAILBOX
   STATION 40+30
   MB ADDRESS "23677"
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
10. INSTALL CENTERLINE SURVEY MONUMENT
    WITH FRAME AND COVER
    @ STA 40+05.55 - CL PC
    SEE SHEET NO 2B-7 FOR DETAIL
11. SEE SHEET 17A FOR DETAIL
    OF THIS AREA.
12. 39+85.89 PC (37.00' LT)
    TC 332.05
13. 39+65.87 PC (13.00' RT)
    TC 332.62
14. CONST LOW PROFILE MOUNTABLE CURB
    SEE SHEET 2B-6 FOR DETAILS
15. POWER POLE BY PGE (TYP)
16. OVERHEAD POWER BY PGE (TYP)
17. SAWCUT EXIST AC PAVEMENT
    AND REMOVE (N)

(1) 12" STM SEWER ~~L = 273' S = 0.0212~~ (B) 272' 0.0207 (B)

△1 (2) STM MH # 15
@ STA ~~40+45~~ (30' LT) 40+44 (B)
RIM = ~~333.22~~ 333.16 (B)
IE ~~325.06~~ 12" IN (N) 324.48 (B)
IE ~~325.06~~ ~~12" IN (W)~~ 324.48 (B)
10" IN (W) △1
IE 324.86 - 12" OUT (S) 324.41 (B)

△1 (3) ~~10" STM SEWER L = 23' S = 0.1270~~
△1 10" STM SEWER L = 23' ~~S = 0.2626~~
(B) 0.2535 (B)

△1 (4) STM CB # 29 (AREA DRAIN TYPE II)
@ STA ~~40+50~~ (53' LT) 40+47 (B)
~~TC 334.27~~ TOG 333.71 (B)
~~IE 330.00~~ - 10" OUT (E)
△1 IE ~~331.15~~ 330.31 (B)

△1 (5) STM CB # 30 (MOD. CG - 48 MH)
(B) @ STA 41+50 (36' LT)
RIM = ~~334.98~~ 334.95 (B)
~~IE 327.54 - 10" IN (E)~~ IE ~~329.00~~ 10" IN (E) △1 328.93 (B)
IE ~~327.37~~ 12" OUT (S) 327.33 (B)

△1 (6) 10" STM SEWER ~~L = 58' S = 0.0483~~ L = 54' ~~S = 0.0100~~ △1
(B) 0.0081 (B)

△1 (7) STM CB # 31 (CG-30)
(B) @ STA 41+50 (22' RT)
TC ~~335.32~~ 335.38 (B)
~~IE 330.32 - 10" OUT (W)~~ IE ~~329.54~~ - 10" OUT (W) △1 329.37 (B)

(8) 12" STM CULVERT ~~L = 83' S = 0.0162~~
STM OUTFALL #5 (B) 80' 0.0148 (B)

(9) STM INLET # 32 (DITCH INLET)
(B) @ STA 41+74 (24' RT)
~~TC 335.45~~ RIM 334.66 (BOTTOM OF GRATE) (B)
IE ~~330.81~~ - 12" IN (N) 331.11 (B)
IE ~~330.61~~ - 12" OUT (W) 330.55 (B)

(10) 12" STM SEWER ~~L = 77'~~ S = 0.0101
(B) 74' (B)

(11) RIP RAP PAD
CLASS 50 RIP RAP
8' LONG x 7' WIDE x 1.5' DEEP
PLACE 1' ABOVE PIPE CROWN

(12) 12" STM SEWER ~~L = 107' S = 0.0215~~
(B) 109' 0.0261 (B)

(13) 4" PP STM SEWER L = 373'

(14) STA 41+45 (39' LT)
PLUG 4" PP

(15) 4" PP STM SEWER L = 349'

STORM SYSTEM "RECORD" DRAWING 11-14-14

REGISTERED PROFESSIONAL ENGINEER
15552PE
OREGON
JULY 25, 1991
DAMON C. WEBSTER
11/18/14
EXPIRES: 6/30/16

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING
WASHINGTON COUNTY OREGON

PLOT STAMP: 11/17/14 7:46A ASTAICH
CAD: 15315_9_11A_ST_PL_PR.DWG, TAB: 9
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NO.	REVISIONS	
△1	REVISION NO. 3	5-20-2013 RRM
(B)	STORM SYSTEM "RECORD" DATA 11-14-14	

SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY
CONSTRUCTION NOTES

PROJECT NUMBER 100096
SHEET NO. 144 OF 274
SHEET TITLE 9

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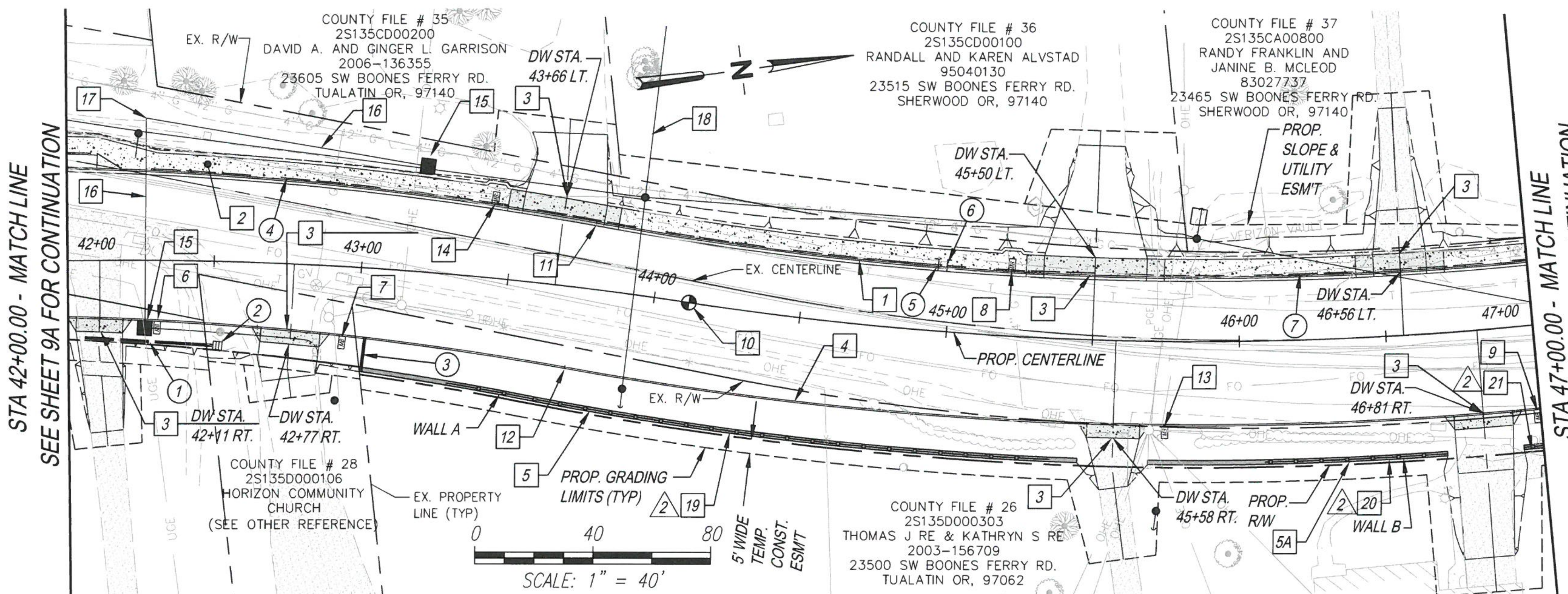
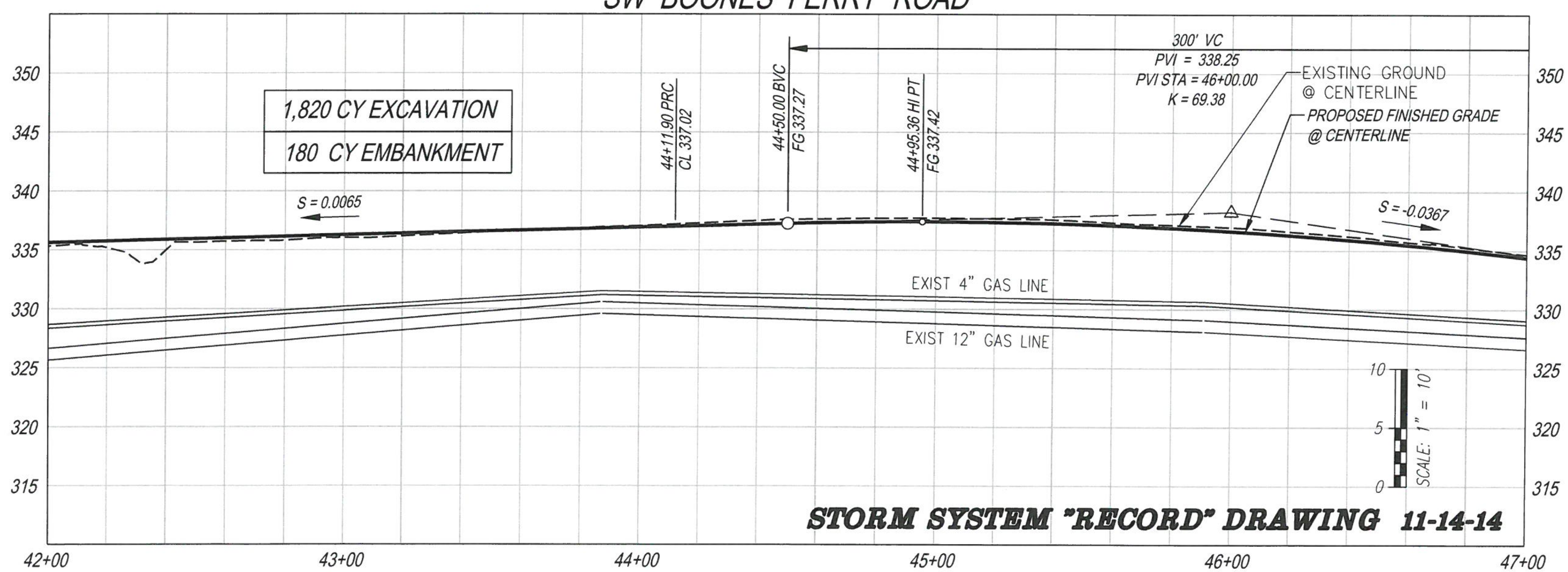
CONSTRUCTION PLAN AND PROFILE



SW BOONES FERRY ROAD



STORM SYSTEM "RECORD" DRAWING 11-14-14

REGISTERED PROFESSIONAL ENGINEER 15582PE
OREGON
JULY 25, 1986
RAMON C. WEBSTER
11/18/14
EXPIRES: 6/30/16

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING

WASHINGTON COUNTY OREGON

PLOT STAMP: 11/17/14 7:48A ASTAICH
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NO.	REVISIONS	
2	ADDENDUM NO. 2	RRM 4-16-2013
B	STORM SYSTEM "RECORD" DATA 11-14-14	

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SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

CONSTRUCTION PLAN AND PROFILE

PROJECT NUMBER
100096

SHEET NO.
147 OF 274

SHEET TITLE
10A

CONSTRUCTION NOTES

THIS SHEET TO FACE SHT. 10A

1. CONST. P.C. CONC. CURB & GUTTER
   SEE SHEET 2B-4 FOR DETAILS
2. CONST. POROUS P.C. CONC. WALK
   SEE SHEET 2B-6 FOR DETAILS
3. CONST. P.C. RESIDENTIAL DRIVEWAY
   SEE SHEET 2B-1 & 2B-2 FOR DETAILS
4. CONST. P.C. CONC. MOUNTABLE VERTICAL CURB
   SEE SHEET 2B-4.1 FOR DETAILS
5. CONST. PREFAB. MODULAR RETAINING WALL A
   SEE SHEET 28A FOR DETAILS

5A. CONST. PREFAB. MODULAR RETAINING WALL B
   SEE SHEET 28A FOR DETAILS

6. CONST. SINGLE MAILBOX
   STATION 42+31
   MB ADDRESS " 23620 "
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
7. CONST. DOUBLE MAILBOX
   STATION 42+95
   MB ADDRESS " 23560 "
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
8. CONST. SINGLE MAILBOX
   STATION 45+21
   MB ADDRESS " 23515 "
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
9. CONST. SINGLE MAILBOX
   STATION 46+99
   MB ADDRESS " 23500 "
   SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
10. INSTALL CENTERLINE SURVEY MONUMENT
    WITH FRAME AND COVER
    @ STA 44+11.90 - CL PRC
    SEE SHEET NO 2B-7 FOR DETAIL
11. 43+77.26 PRC (22.52' LT)
    TC 336.58
12. 43+58.83 PRC (34.82' LT)
    TC 336.30
13. CONST. SINGLE MAILBOX
    STATION 45+75
    MB ADDRESS " 23550 "
    SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
14. CONST. SINGLE MAILBOX
    STATION 43+43
    MB ADDRESS " 23605 "
    SEE SHEETS 2B-7, 2B-8, AND 2B-9 FOR DETAILS
15. PROPOSED POWER VAULT BY PGE
16. PROPOSED POWER CONDUIT BY PGE
17. POWER POLE BY PGE (TYP)
18. OVERHEAD POWER BY PGE (TYP)
19. BLACK VINYL COATED CHAINLINK FENCE
    WALL A: STA. 0+30 TO STA. 2+37
    (2) ~~3" FROM BACK OF WALL~~
    REFER TO ODOT STD DRAWING
    RD815. INSTALL FENCE ON WALL.
20. BLACK VINYL COATED CHAINLINK FENCE
    WALL B: STA. 0+40 TO STA. 1+12
    (2) ~~3" FROM BACK OF WALL~~
    REFER TO ODOT STD DRAWING
    RD815. INSTALL FENCE ON WALL.
21. BLACK VINYL COATED CHAINLINK FENCE
    WALL C: STA. 0+00 TO STA. 0+36
    (2) ~~3" FROM BACK OF WALL~~
    REFER TO ODOT STD DRAWING
    RD815. INSTALL FENCE ON WALL.

(1) 12" STM SEWER ~~L = 77'~~ (B) 74' S = 0.0101 (B)

(2) STM INLET # 33 (DITCH INLET)
@ STA ~~42+52~~ (29' RT) 42+50 (B)
~~TC 335.83~~ RIM 334.68 (BOTTOM OF GRATE) (B)
IE ~~331.58~~ - 12" OUT (S) 331.86 (B)

(3) 4" D.I.P. FOOTING DRAIN CONNECTION
THRU CURB FACE - L = 12' UNABLE TO VERIFY

(4) 4" PP STM SEWER L = 349'

(5) STA 44+95 (23' LT)
PLUG 4" PP

(6) STA 44+98 (23' LT)
PLUG 4" PP

(7) 4" PP STM SEWER L = 335'

STORM SYSTEM "RECORD" DRAWING 11-14-14

REGISTERED PROFESSIONAL ENGINEER
15552PE
OREGON
JULY 25, 1995
DAMON C. WEBSTER
11/18/14
EXPIRES: 6/30/16

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING
WASHINGTON COUNTY OREGON

PLOT STAMP: 11/17/14 7:48A ASTAICH
CAD: 15315_9_11A_ST_PL_PR.DWG, TAB: 10
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NO.	REVISIONS	
2	ADDENDUM NO 2	RRM 4-16-2013
B	STORM SYSTEM "RECORD" DATA 11-14-14	

SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

CONSTRUCTION NOTES

PROJECT NUMBER
100096

SHEET NO.
146 OF 274

SHEET TITLE
10

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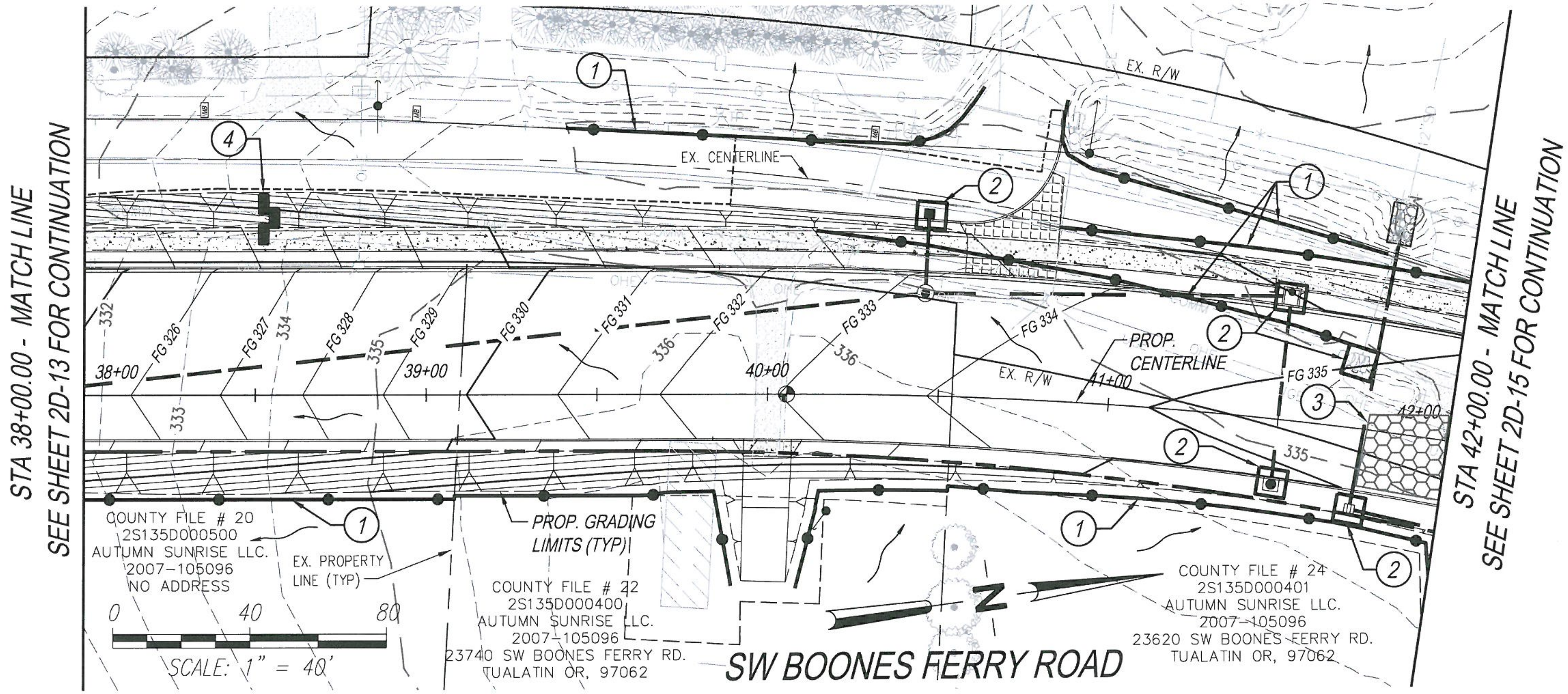
Appendix E

EROSION & SEDIMENT CONTROL PLAN



LEGEND

- EXISTING CONTOUR (280)
- FINISHED CONTOURS (MINOR) (FG 281)
- FINISHED CONTOURS (MAJOR) (FG 280)
- SILT FENCE
- CHECK DAM BIO-FILTER BAG
- DIRECTION OF FLOW
- TEMPORARY STORM INLET PROTECTION
- GRAVEL CONSTRUCTION ENTRANCE

EROSION & SEDIMENT CONTROL NOTES

1. CONSTRUCT SEDIMENT FENCE
   SEE SHEET 2D-3 & 2D-4 FOR DETAILS
2. CONSTRUCT INLET PROTECTION
   SEE SHEET 2D-4 FOR DETAILS
3. CONSTRUCT GRAVEL CONSTRUCTION ENTRANCE
   SEE SHEET 2D-3 FOR DETAILS
4. CONSTRUCT CHECK DAM BIO-FILTER BAG
   SEE SHEET 2D-3 FOR DETAILS

"RECORD" DRAWING 11-14-14

NOTE:
EROSION AND SEDIMENT CONTROLS SELECTION AND PLACEMENT MUST BE CONSISTENT AND APPROPRIATE FOR CONSTRUCTION PHASING AT ALL TIMES. CONTROLS SHOWN ON PLANS MAY NOT APPLY TO ALL CONSTRUCTION PHASES.

REGISTERED PROFESSIONAL ENGINEER 15552PE OREGON JULY 25, 1991 DAMON C. WEBSTER
1/31/13
EXPIRES: 6/30/14

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING
WASHINGTON COUNTY OREGON

PLOT STAMP: 01/31/13 10:12A BFRANCO
CAD: 15315_2D-15_2D-17_ESC_3.DWG, TAB: 2D-14
PATH: W:\15315\CIVIL\DWG\SHEETS\

NO.	REVISIONS

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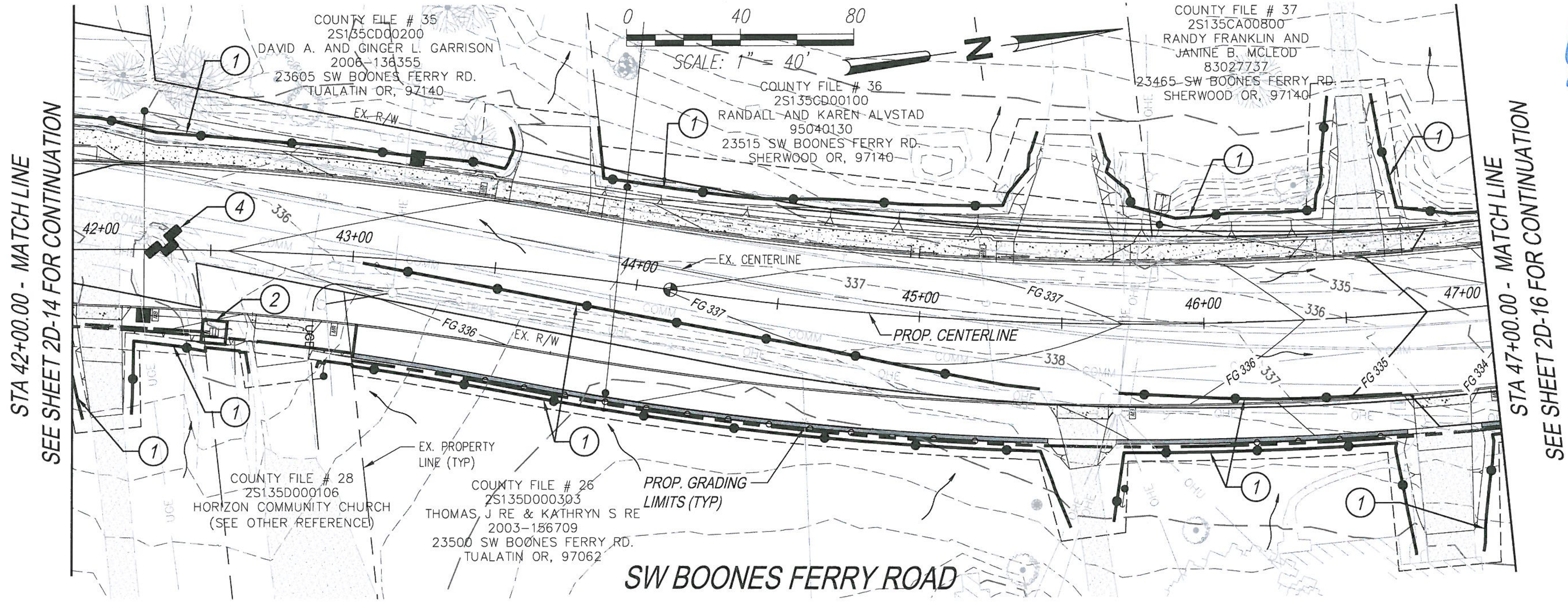
SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

EROSION & SEDIMENT CONTROL PLAN

PROJECT NUMBER 100096
SHEET NO. 80 OF 274
SHEET TITLE 2D-14

EROSION & SEDIMENT CONTROL PLAN



LEGEND

- EXISTING CONTOUR (— — —280— — —)
- FINISHED CONTOURS (MINOR) (FG 281)
- FINISHED CONTOURS (MAJOR) (FG 280)
- SILT FENCE
- CHECK DAM BIO-FILTER BAG
- DIRECTION OF FLOW
- TEMPORARY STORM INLET PROTECTION
- GRAVEL CONSTRUCTION ENTRANCE

EROSION & SEDIMENT CONTROL NOTES

1. CONSTRUCT SEDIMENT FENCE
   SEE SHEET 2D-3 & 2D-4 FOR DETAILS
2. CONSTRUCT INLET PROTECTION
   SEE SHEET 2D-4 FOR DETAILS
3. CONSTRUCT GRAVEL CONSTRUCTION ENTRANCE
   SEE SHEET 2D-3 FOR DETAILS
4. CONSTRUCT CHECK DAM BIO-FILTER BAG
   SEE SHEET 2D-3 FOR DETAILS

"RECORD" DRAWING 11-14-14

NOTE:
EROSION AND SEDIMENT CONTROLS SELECTION AND PLACEMENT MUST BE CONSISTENT AND APPROPRIATE FOR CONSTRUCTION PHASING AT ALL TIMES. CONTROLS SHOWN ON PLANS MAY NOT APPLY TO ALL CONSTRUCTION PHASES.

REGISTERED PROFESSIONAL ENGINEER 15552PE OREGON JULY 25, 1997 DAMON C. WEBSTER
1/31/13
EXPIRES: 6/30/14

DEPARTMENT OF LAND USE & TRANSPORTATION ENGINEERING
WASHINGTON COUNTY OREGON

PLOT STAMP: 01/31/13 10:12A BFRANCO
CAD: 15315_2D-15_2D-17_ESC_3.DWG, TAB: 2D-15
PATH: W:\15315\CIVIL\DWG\SHEETS\

NO.	REVISIONS

MacKay Sposito
ENERGY PUBLIC WORKS LAND DEVELOPMENT
www.mackaysposito.com

SW BOONES FERRY RD.
SW DAY RD. TO SW NORWOOD RD.
WASHINGTON COUNTY

EROSION & SEDIMENT CONTROL PLAN

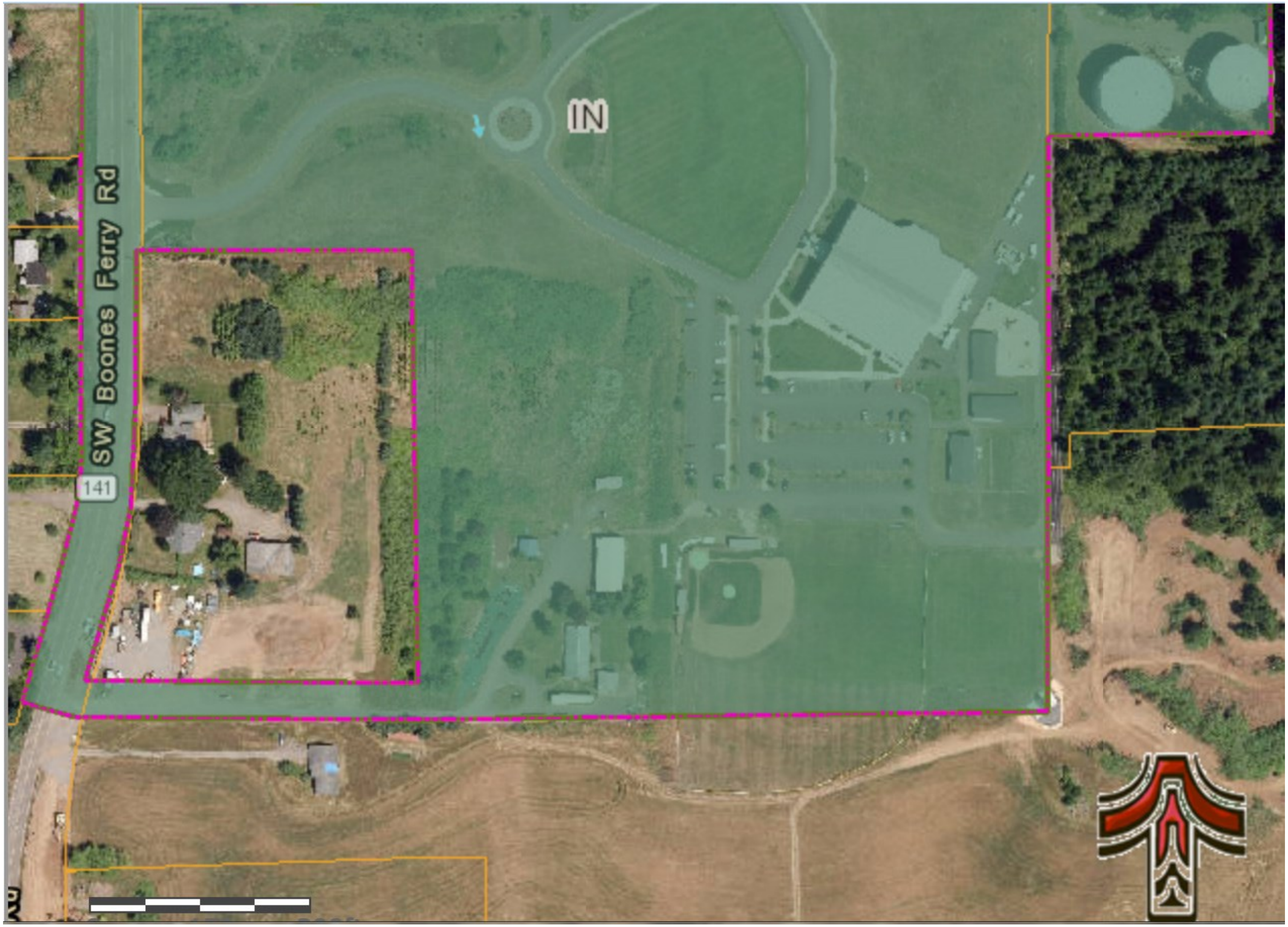
PROJECT NUMBER 100096
SHEET NO. 81 OF 274
SHEET TITLE 2D-15

Appendix F

Tualatin Planning Districts

Planning Districts

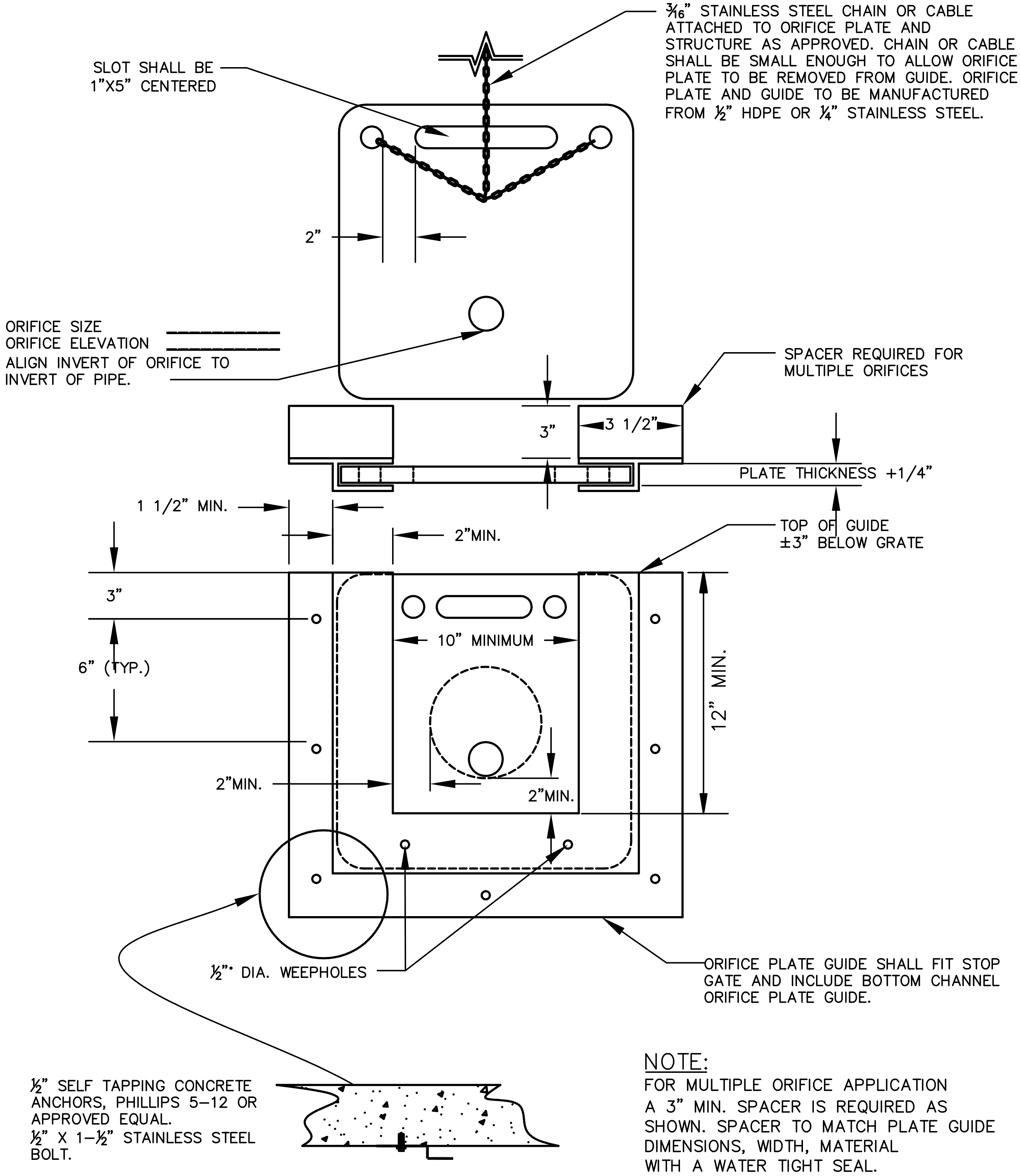
- Commercial Office (CO)
- Central Commercial (CC)
- General Commercial (CG)
- Recreational Commercial (CR)
- Medical Commercial (MC)
- Light Manufacturing (ML)
- General Manufacturing (MG)
- Manufacturing Park (MP)
- Manufacturing Business Park (MBP)
- Low Density Residential (RL)
- Medium Low Density Residential
- Medium High Density Residential (RMH)
- High Density Residential (RH)
- High Density/High Rise Residential (RH/HR)
- Institutional (IN)



IN
SW Boones Ferry Rd
141


141
23643
SW Boones Ferry Rd

Appendix G



NOTE:

FOR MULTIPLE ORIFICE APPLICATION A 3" MIN. SPACER IS REQUIRED AS SHOWN. SPACER TO MATCH PLATE GUIDE DIMENSIONS, WIDTH, MATERIAL WITH A WATER TIGHT SEAL.

ORIFICE PLATE AND GUIDE

DRAWING NO. 730

REVISED 12-06

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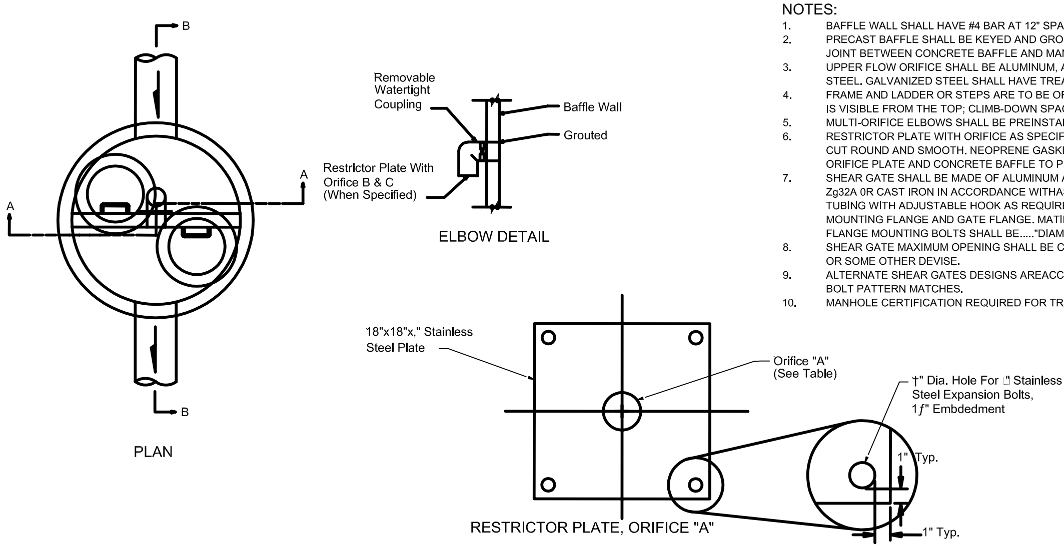
FLOW CONTROL STRUCTURE DETAIL

DRAWING NO. 270

REVISED 12-06



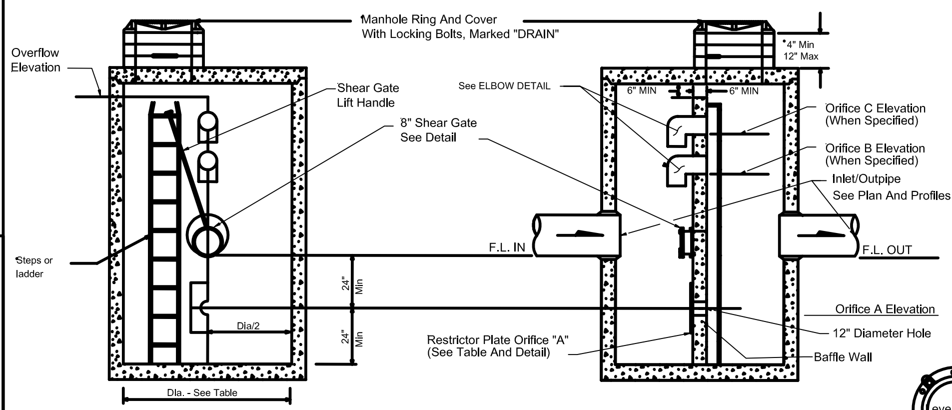
NOTES:

1. BAFFLE WALL SHALL HAVE #4 BAR AT 12" SPACING EACH WAY.
2. PRECAST BAFFLE SHALL BE KEYED AND GROUTED IN PLACE. JOINT BETWEEN CONCRETE BAFFLE AND MANHOLE WALL SHALL BE WATERTIGHT.
3. UPPER FLOW ORIFICE SHALL BE ALUMINUM, ALUMINIZED STEEL OR GALVANIZED STEEL. GALVANIZED STEEL SHALL HAVE TREATMENT 1.
4. FRAME AND LADDER OR STEPS ARE TO BE OFFSET SO THAT: SHEAR GATE IS VISIBLE FROM THE TOP; CLIMB-DOWN SPACE IS CLEAR OF RISER AND GATE; FRAME IS CLEAR OF CURB.
5. MULTI-ORIFICE ELBOWS SHALL BE PREINSTALLED TO INSURE LADDER CLEARANCE.
6. RESTRICTOR PLATE WITH ORIFICE AS SPECIFIED IN THE CONTRACT. OPENING IS TO BE CUT ROUND AND SMOOTH. NEOPRENE GASKET SHALL BE INSTALLED BETWEEN THE ORIFICE PLATE AND CONCRETE BAFFLE TO PROVIDE A WATERTIGHT SEAL.
7. SHEAR GATE SHALL BE MADE OF ALUMINUM ALLOY IN ACCRDANCE WITH ASTM B 26M AND ASTM B 275, DESIGNATION Zg32A 0R CAST IRON IN ACCORDANCE WITHASTM A 48, CLASS 30B. LIFT HANDLE MAY BE SOLID ROD OR HOLLOW TUBING WITH ADJUSTABLE HOOK AS REQUIRED. NEOPRENE RUBBER GASKET REROUIRED BETWEEN RISER MOUNTING FLANGE AND GATE FLANGE. MATING SURFACES OF LID AND BODY SHALL BE MACHINED FOR PROPER FIT. FLANGE MOUNTING BOLTS SHALL BE....."DIAMETER STAINLESS STEEL.
8. SHEAR GATE MAXIMUM OPENING SHALL BE CONTROLLED BY LIMITED HINGE MOVEMENT, STOP TAB OR SOME OTHER DEVISE.
9. ALTERNATE SHEAR GATES DESIGNS AREACCEPTABLE, IF MATERIAL SPECIFICATIONS ARE MET AND FLANGE BOLT PATTERN MATCHES.
10. MANHOLE CERTIFICATION REQUIRED FOR TRAFFIC LOADING.

FLOW CONTROL STRUCTURE TABLE

Diameter Of Manhole (In.)	
F.L. (In)	
F.L. (Out)	
Outlet Pipe Diameter (In.)	
Number Of Orifice	
Orifice A Elevation	
Diameter Of Orifice A (In.)	
Orifice B Elevation	
Diameter Of Orifice B (In.)	
Orifice C Elevation	
Diameter Of Orifice C (In)	
Overflow Elevation	
Rim Elevation	
Riser Diameter (In.)	

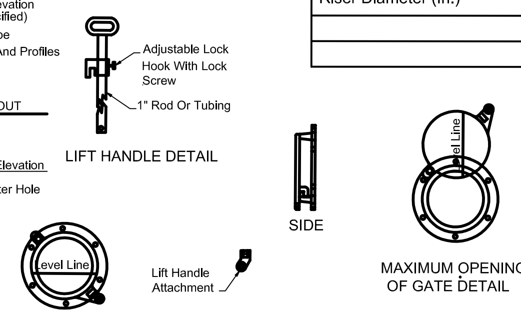
DRAINAGE DETAILS



SECTION A-A

ELEVATION

SECTION B-B



SHEAR GATE
AS MANUFACTURED BY KENNEDY VALVE OR EQUAL

FLOW CONTROL STRUCTURE DETAIL
NTS

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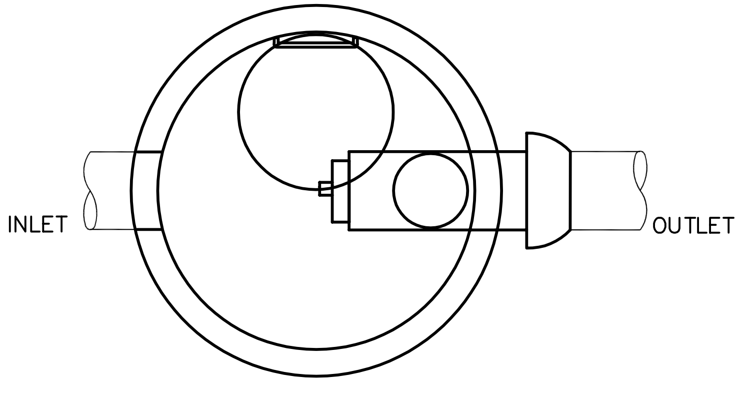
NOTES:
1. ALL MANHOLE SECTIONS SHALL CONFORM TO THE REQUIREMENTS OF ASTM C-478 AND APPLICABLE PROVISIONS OF STD. MANHOLE DRAWING NO. 010
2. INLET AND OUTLET PIPE NOT TO EXCEED 18"DIA.
3. PROVIDE SPECIAL DETAIL FOR OUTLET FLOW CONTROL EXCEEDING 18" DIA.
4. ALL OUTLETS SHALL HAVE FLOW CONTROL DEVICE.



PLAN

SUMP VOLUME AVAILABLE

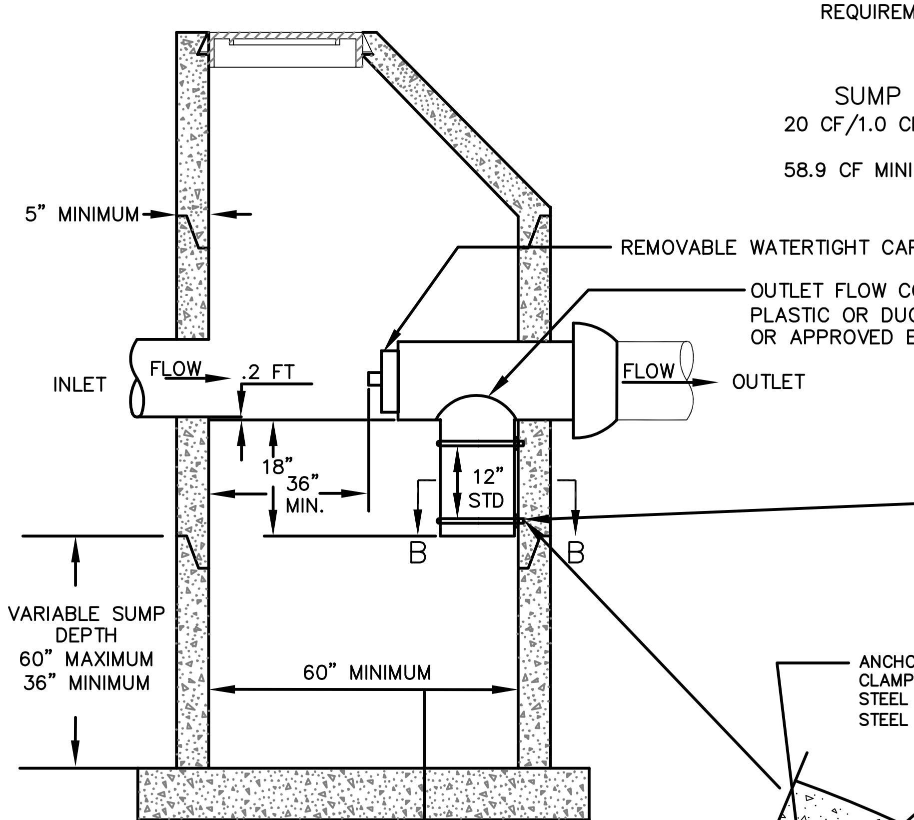
	MINIMUM	MAXIMUM
60" M.H.=	58.9 CF	98.1 CF
72" M.H.=	84.8 CF	141.3 CF
84" M.H.=	115.4 CF	192.3 CF

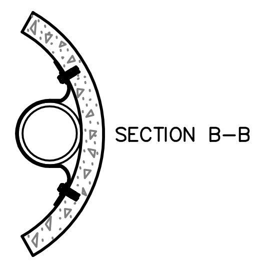
PROVIDE SPECIAL DETAIL FOR VOLUME REQUIREMENTS EXCEEDING 192.3 CF

SUMP VOLUME REQUIREMENTS

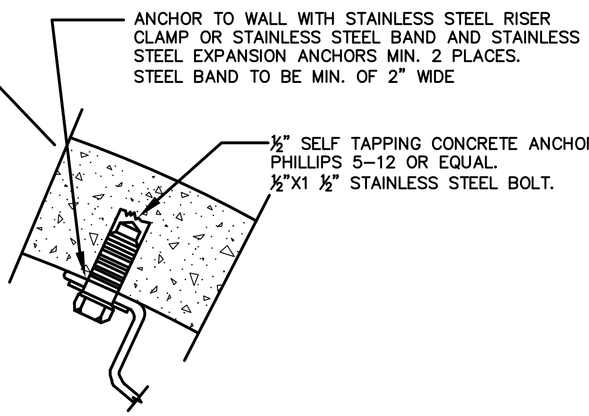
20 CF/1.0 CFS OF INFLOW

58.9 CF MINIMUM REQUIRED





MANHOLE DIAMETER TO BE DETERMINED BY:
1. SUMP VOLUME REQUIREMENTS.
2 NUMBER AND SIZE OF INLETS & OUTLETS.



CLAMP DETAIL
(SECTION A-A)
N.T.S.

WATER QUALITY MANHOLE (MECHANICAL)

DRAWING NO. 240

REVISED 12-06

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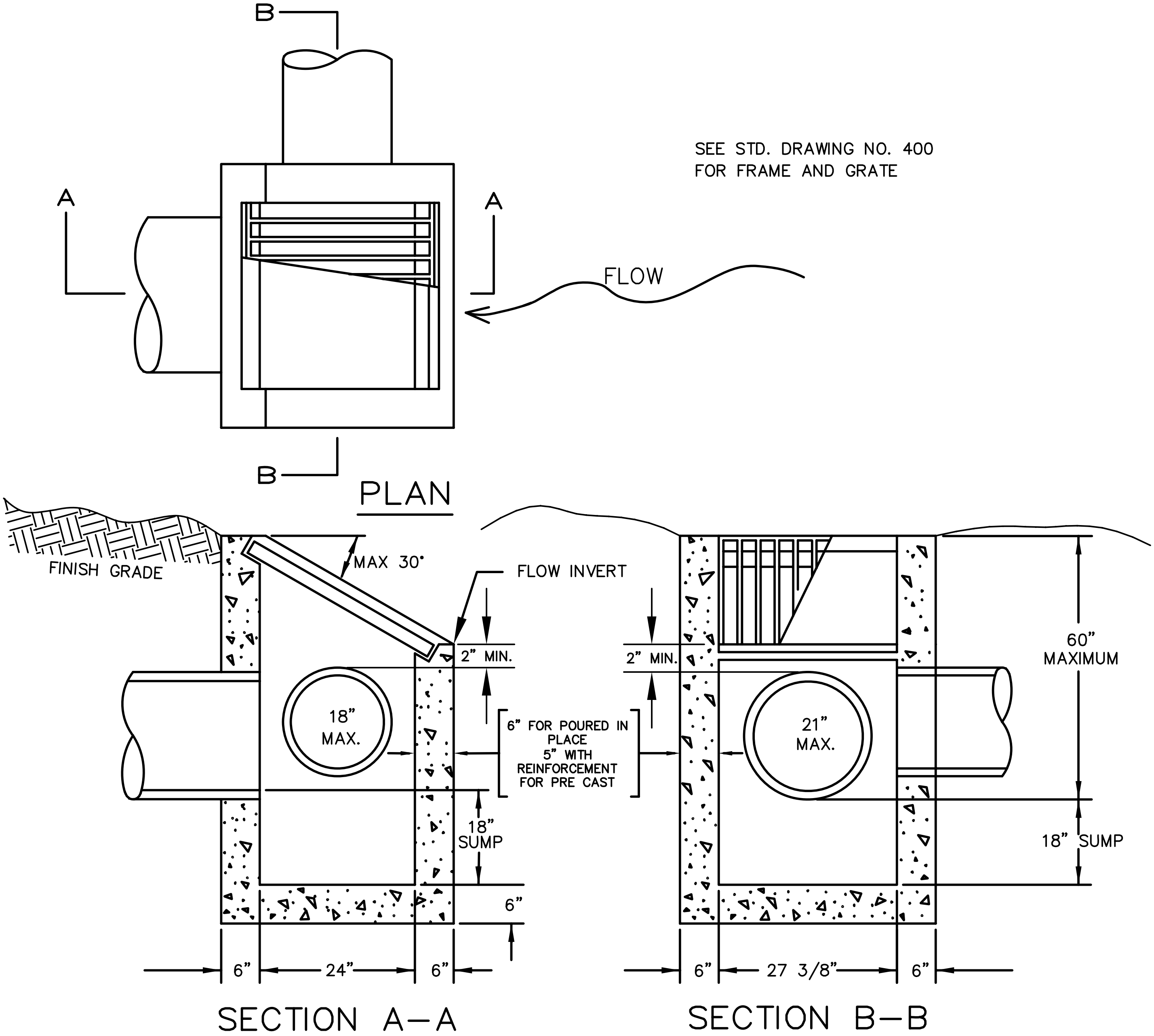

NOTES:

1. ALL PRE CAST SECTIONS SHALL CONFORM TO REQUIREMENTS OF ASTM C–478.
2. INSTALL STRUCTURE ON MINIMUM OF 8" OF 3/4" – 0" COMPACTED BASE MATERIAL.
3. PRE CAST REINFORCEMENT SHALL BE REBAR MEETING ASTM A615 GRADE 60 OR WELDED WIRE MEETING ASTM A497
4. ALL POURED IN PLACE CONCRETE SHALL HAVE A 28 DAY STRENGTH OF 3000 PSI AND SLUMP OF 2" TO 4".
5. PRE–CAST STRUCTURE'S CONFORMING TO O.D.O.T. TYPE G–2 CATCH BASIN DESIGN/WITH DITCH INLET TOP ARE AN ACCEPTABLE ALTERNATE. ALL GRATE MATERIALS SHALL MEET C.W.S. STANDARDS AS SHOWN ON DETAIL #400

DITCH INLET

DRAWING NO. 390

REVISED 05–07

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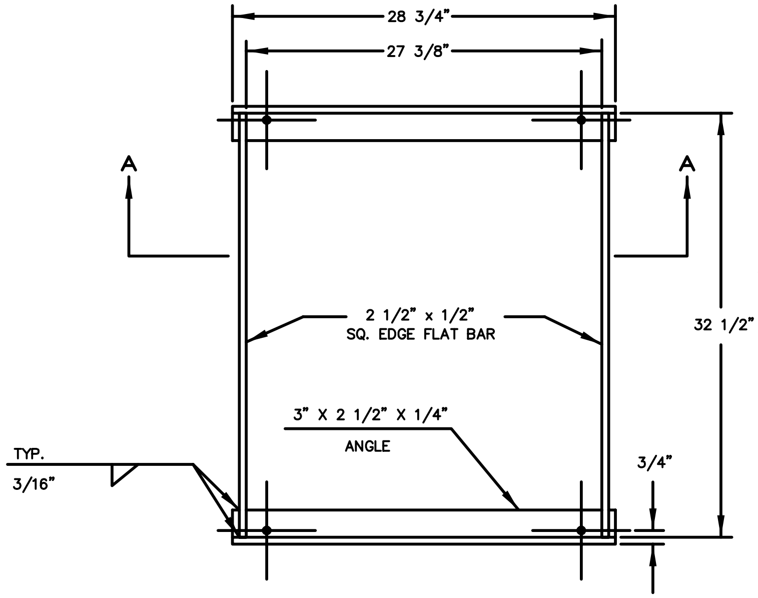
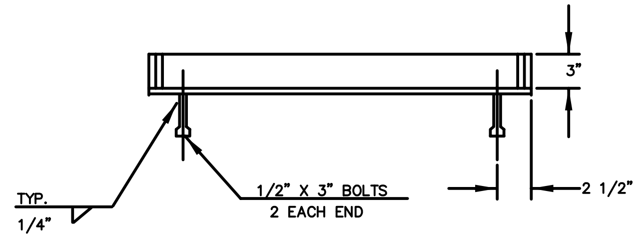
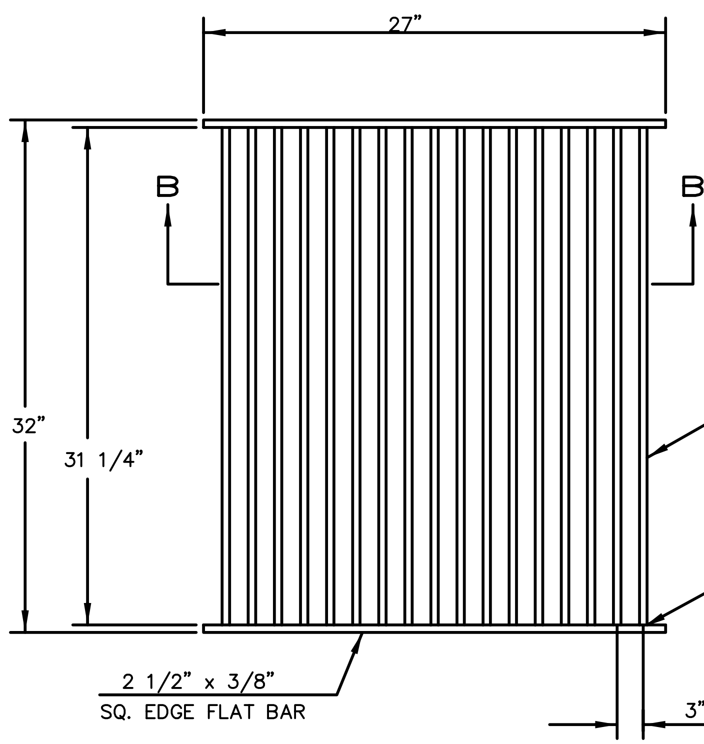
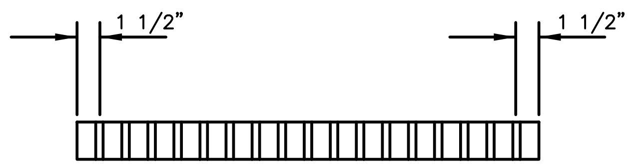


PLAN



SECTION A–A





SECTION B–B

PLAN

NOTE:
FRAME AND GRATE SHALL BE NEW STRUCTURAL ASTM A–36 FLAT BAR STEEL OR APPROVED EQUAL.

DITCH INLET FRAME AND GRATE

DRAWING NO. 400

REVISED 12–06

Clean Water Services
Our commitment is clear.

Appendix H

Summary for Subcatchment 17S: Ex Aux 5

Runoff = 1.17 cfs @ 8.13 hrs, Volume= 0.581 af, Depth= 1.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25yr Rainfall=3.90"

Area (ac)	CN	Description
0.200	98	Paved roads w/curbs & sewers, HSG B
4.000	65	2 acre lots, 12% imp, HSG B
1.600	74	Farmsteads, HSG B
5.800	69	Weighted Average
5.120		88.28% Pervious Area
0.680		11.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0100	0.09		**Sheet Flow, Field** Cultivated: Residue>20% n= 0.170 P2= 2.50"
6.5	500	0.0200	1.27		**Shallow Concentrated Flow, Field** Cultivated Straight Rows Kv= 9.0 fps
0.5	100	0.0400	3.22		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
0.6	105	0.0400	3.00		**Shallow Concentrated Flow, Grass** Grassed Waterway Kv= 15.0 fps
16.9	755	Total			

From County Storm Drainage Report for SW Boones Ferry Road (Jan 2013), PDF Page 59 of 152.

Table LU_a. ORIGINAL Subbasin Areas with Future Land Use Conditions

Weighted Curve Numbers used in HEC-HMS Hydrologic Modeling for Varying Land Use Cases

Weighted average CN Calculations

Area (ac)	CN	Description		
0.200	98	Paved roads w/curbs & sewers, HSG B		
4.000	65	2 acre lots, 12% imp, HSG B [At 4 acres this is two lots that are 2 acres each.]		
1.600	74	Farmsteads, HSG B	Calibration-Check Washington County (OK)	
5.8	69	Weighted Average		68.6

Ongoing Land Use (LU)

Area (ac)	CN	Description		
0.200	98	Paved roads w/curbs & sewers, HSG B		
2.000	65	2 acre lot, 12% imp, HSG B		
2.000	92	Urban Districts: Commercial and Business		
1.600	74	Farmsteads, HSG B		LU Case CN
5.8	77.9	Weighted Average	Weighted Average CN	77.9

Full Build-out (BO)

Area (ac)	CN	Description		
0.200	98	Paved roads w/curbs & sewers, HSG B		
2.000	85	2 acre lot, 12% imp, HSG B		
2.000	92	Urban Districts: Commercial and Business		
1.600	85	Residential Districts: 1/8 acre		BO Case CN
5.8	87.9	Weighted Average	Weighted Average CN	87.9

Global Summary Results for Run "Lucini_o_17S"

Project: BF_o_Lucini Simulation Run: Lucini_o_17S

Start of Run:	01Jan3000, 00:00	Basin Model:	Above_Lucini
End of Run:	02Jan3000, 00:10	Meteorologic Model:	Met 1
Compute Time:	30Aug2016, 11:57:36	Control Specifications:	Control 1

Show Elements: All Elements Volume Units: (•) IN ( ) AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Lucini_o_17S	0.009048	1.17	01Jan3000, 08:06	1.20

Summary Results for Subbasin "Lucini_o_17S"

Project: BF_o_Lucini Simulation Run: Lucini_o_17S
Subbasin: Lucini_o_17S

Start of Run:	01Jan3000, 00:00	Basin Model:	Above_Lucini
End of Run:	02Jan3000, 00:10	Meteorologic Model:	Met 1
Compute Time:	30Aug2016, 11:57:36	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

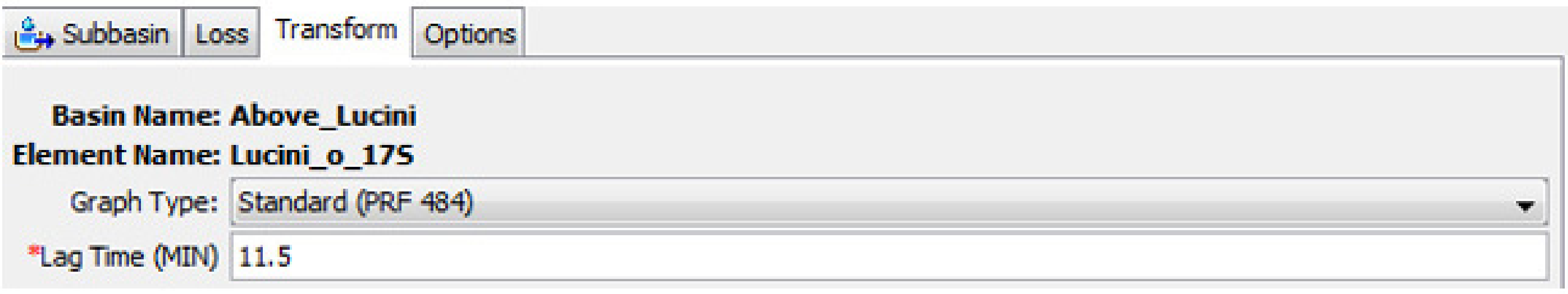
Peak Discharge:	1.17 (CFS)	Date/Time of Peak Discharge:	01Jan3000, 08:06
Precipitation Volume:	3.90 (IN)	Direct Runoff Volume:	1.20 (IN)
Loss Volume:	2.70 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	1.20 (IN)	Discharge Volume:	1.20 (IN)

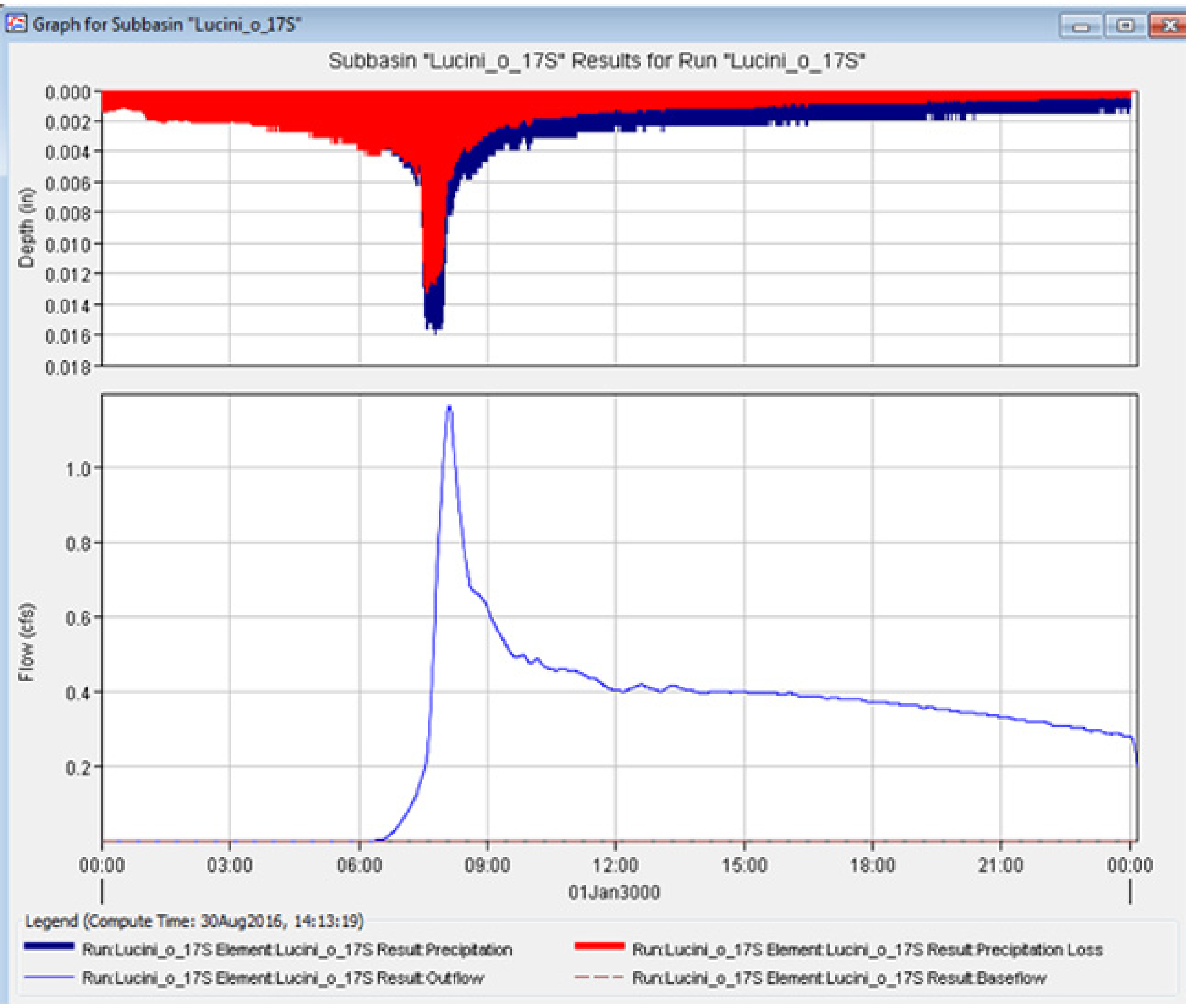
Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini
Element Name: Lucini_o_17S

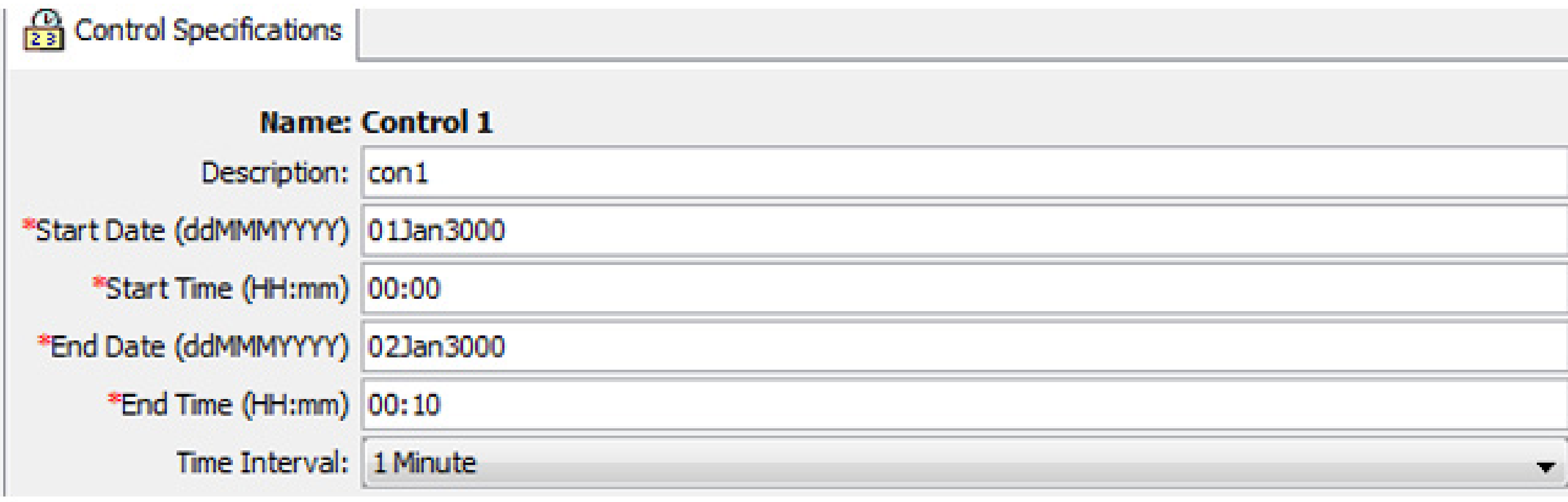
Description:	sub1
Downstream:	--None--
*Area (MI2)	0.009048
Latitude Degrees:	
Latitude Minutes:	
Latitude Seconds:	
Longitude Degrees:	
Longitude Minutes:	
Longitude Seconds:	
Canopy Method:	--None--
Surface Method:	--None--
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	--None--


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini
Element Name: Lucini_o_17S
Initial Abstraction (IN)
*Curve Number: 69
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini
Element Name: Lucini_o_17S
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 11.5


Graph for Subbasin "Lucini_o_17S"
Subbasin "Lucini_o_17S" Results for Run "Lucini_o_17S"
Depth (in)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
Flow (cfs)
1.0
0.8
0.6
0.4
0.2
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan3000
Legend (Compute Time: 30Aug2016, 14:13:19)
Run:Lucini_o_17S Element:Lucini_o_17S Result:Precipitation
Run:Lucini_o_17S Element:Lucini_o_17S Result:Precipitation Loss
Run:Lucini_o_17S Element:Lucini_o_17S Result:Outflow
Run:Lucini_o_17S Element:Lucini_o_17S Result:Baseflow


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini
Element Name: Lucini_o_17S
Observed Flow: --None--
Observed Stage: --None--
Observed SWE: --None--
Elev-Discharge: --None--
Ref Flow (CFS)
Ref Label:


Control Specifications
Name: Control 1
Description: con1
*Start Date (ddMMMYYYY) 01Jan3000
*Start Time (HH:mm) 00:00
*End Date (ddMMMYYYY) 02Jan3000
*End Time (HH:mm) 00:10
Time Interval: 1 Minute

Global Summary Results for Run "Lucini_o_17S_base_aa"

Project: BF_o_17S_base_aa   Simulation Run: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 12:30:08   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: (•) IN ( ) AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Lucini_o_17S_base_aa	0.00678	0.89	01Jan3000, 08:05	1.20

Summary Results for Subbasin "Lucini_o_17S_base_aa"

Project: BF_o_17S_base_aa   Simulation Run: Lucini_o_17S_base_aa
Subbasin: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 12:30:08   Control Specifications: Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

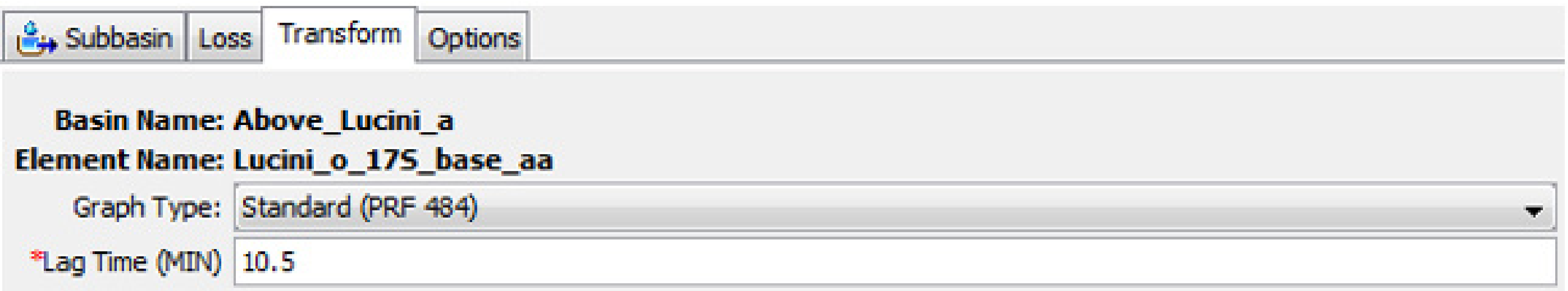
Peak Discharge:	0.89 (CFS)	Date/Time of Peak Discharge:	01Jan3000, 08:05
Precipitation Volume:	3.90 (IN)	Direct Runoff Volume:	1.20 (IN)
Loss Volume:	2.70 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	1.20 (IN)	Discharge Volume:	1.20 (IN)

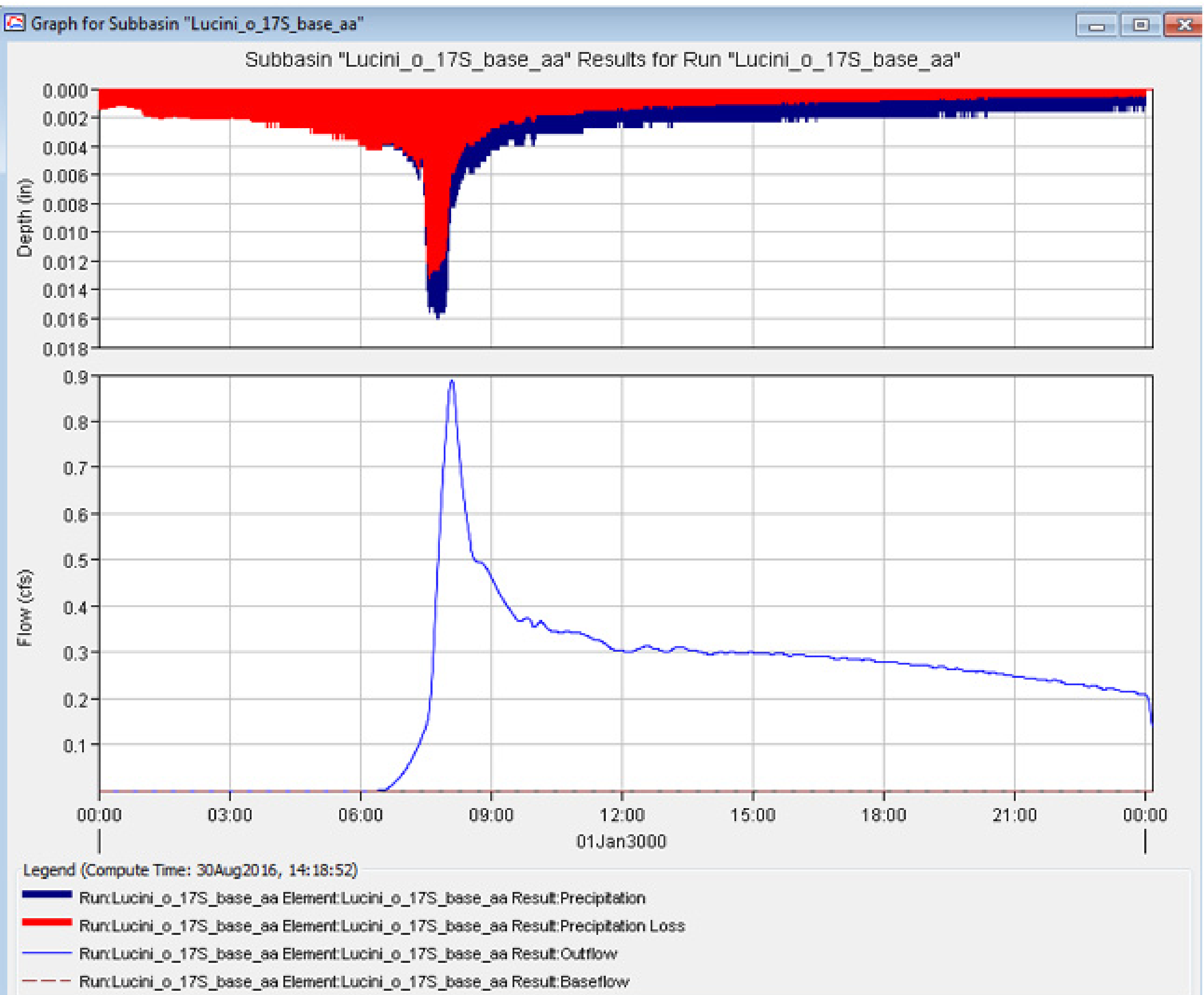
Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa

Description:	sub1
Downstream:	--None--
*Area (MI2)	0.00678
Latitude Degrees:	
Latitude Minutes:	
Latitude Seconds:	
Longitude Degrees:	
Longitude Minutes:	
Longitude Seconds:	
Canopy Method:	--None--
Surface Method:	--None--
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	--None--


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa
Initial Abstraction (IN)
*Curve Number: 69
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 10.5


Graph for Subbasin "Lucini_o_17S_base_aa"
Subbasin "Lucini_o_17S_base_aa" Results for Run "Lucini_o_17S_base_aa"
Depth (in)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
Flow (cfs)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan3000
Legend (Compute Time: 30Aug2016, 14:18:52)
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Precipitation
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Precipitation Loss
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Outflow
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Baseflow

Global Summary Results for Run "Lucini_o_17S_base_aa"

Project: Lucini_o-17S_LU   Simulation Run: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 12:56:51   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: (•) IN ( ) AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Lucini_o_17S_base_aa	0.006781	1.71	01Jan3000, 08:04	1.80

Summary Results for Subbasin "Lucini_o_17S_base_aa"

Project: Lucini_o-17S_LU   Simulation Run: Lucini_o_17S_base_aa
Subbasin: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 12:56:51   Control Specifications: Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

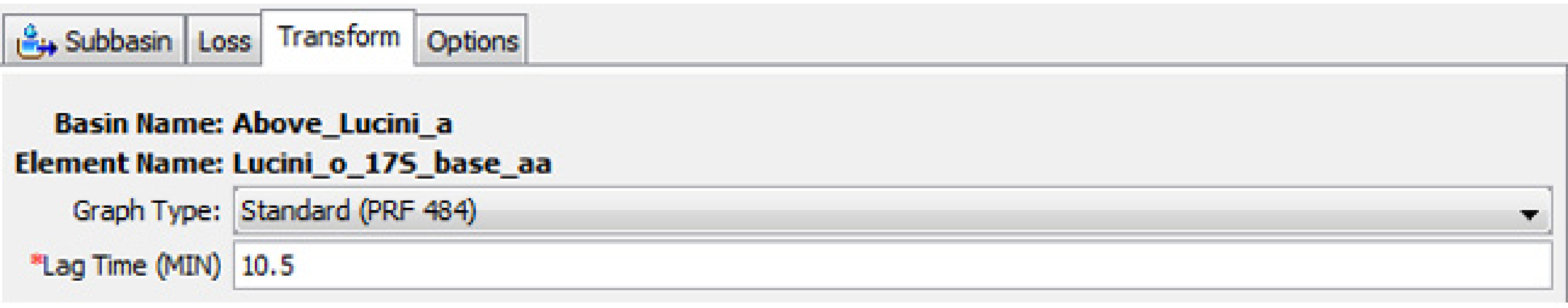
Peak Discharge:	1.71 (CFS)	Date/Time of Peak Discharge:	01Jan3000, 08:04
Precipitation Volume:	3.90 (IN)	Direct Runoff Volume:	1.80 (IN)
Loss Volume:	2.10 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	1.80 (IN)	Discharge Volume:	1.80 (IN)

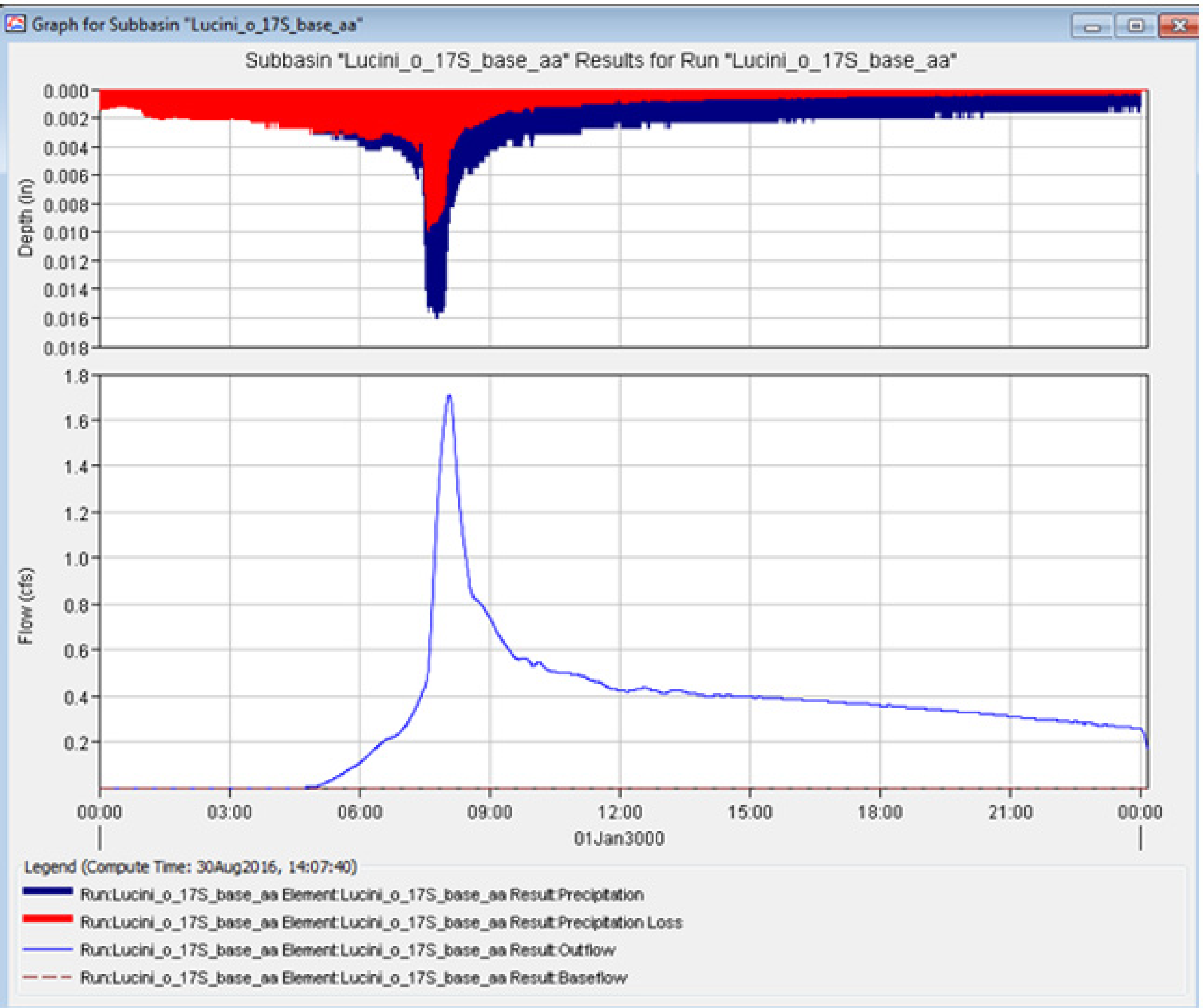
Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa

Description:	sub1
Downstream:	--None--
*Area (MI2)	0.006781
Latitude Degrees:	
Latitude Minutes:	
Latitude Seconds:	
Longitude Degrees:	
Longitude Minutes:	
Longitude Seconds:	
Canopy Method:	--None--
Surface Method:	--None--
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	--None--


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa
Initial Abstraction (IN)
*Curve Number: 77.9
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 10.5


Graph for Subbasin "Lucini_o_17S_base_aa"
Subbasin "Lucini_o_17S_base_aa" Results for Run "Lucini_o_17S_base_aa"
Depth (in)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
Flow (cfs)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan3000
Legend (Compute Time: 30Aug2016, 14:07:40)
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Precipitation
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Precipitation Loss
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Outflow
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Baseflow

Global Summary Results for Run "Lucini_o_17S_base_aa"

Project: Lucini_o_17S_BO   Simulation Run: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 13:38:09   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: IN AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Lucini_o_17S_base_aa	0.006781	2.85	01Jan3000, 08:02	2.63

Summary Results for Subbasin "Lucini_o_17S_base_aa"

Project: Lucini_o_17S_BO   Simulation Run: Lucini_o_17S_base_aa
Subbasin: Lucini_o_17S_base_aa

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 13:38:09   Control Specifications: Control 1

Volume Units: IN AC-FT

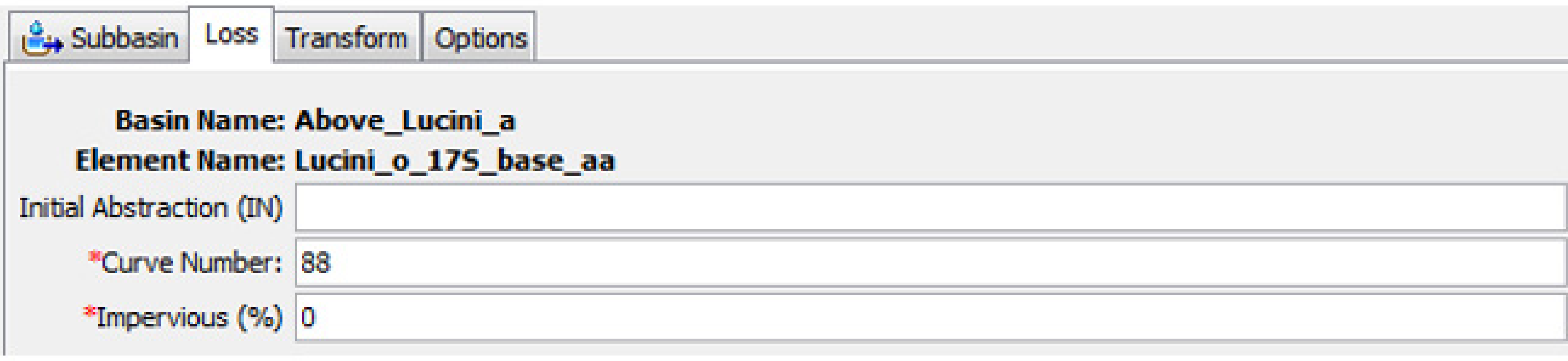
Computed Results

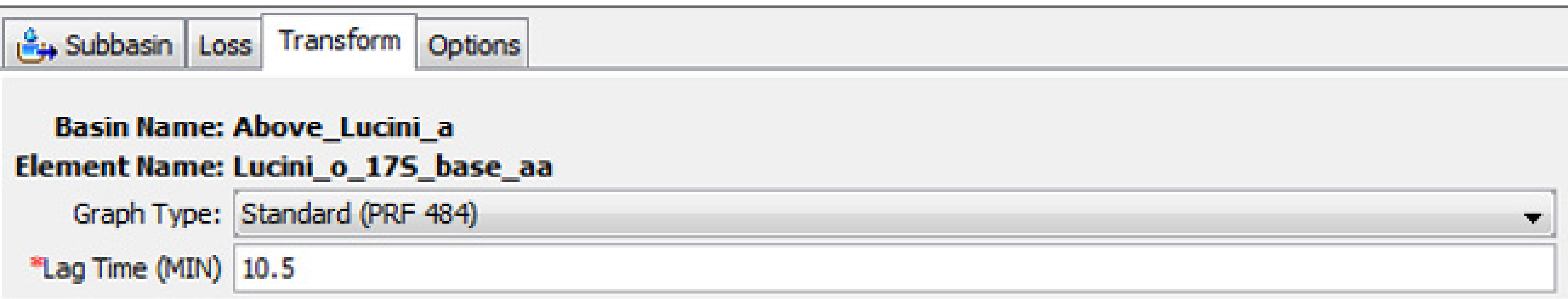
Peak Discharge: 2.85 (CFS)   Date/Time of Peak Discharge: 01Jan3000, 08:02
Precipitation Volume: 3.90 (IN)   Direct Runoff Volume: 2.63 (IN)
Loss Volume: 1.26 (IN)   Baseflow Volume: 0.00 (IN)
Excess Volume: 2.64 (IN)   Discharge Volume: 2.63 (IN)

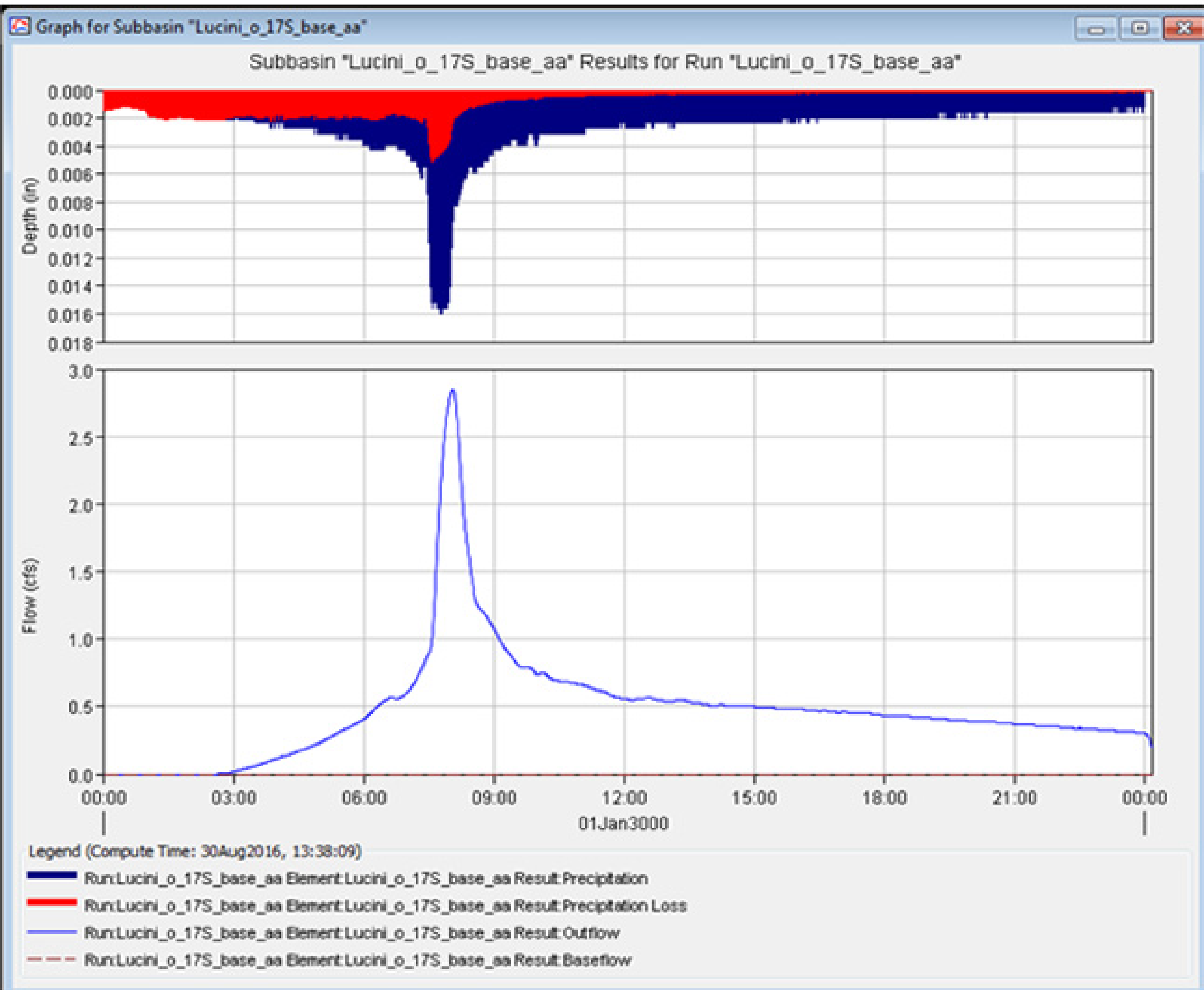
Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa

Description: sub1
Downstream: --None--
*Area (MI2) 0.006781
Latitude Degrees:
Latitude Minutes:
Latitude Seconds:
Longitude Degrees:
Longitude Minutes:
Longitude Seconds:
Canopy Method: --None--
Surface Method: --None--
Loss Method: SCS Curve Number
Transform Method: SCS Unit Hydrograph
Baseflow Method: --None--


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa
Initial Abstraction (IN)
*Curve Number: 88
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: Lucini_o_17S_base_aa
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 10.5


Graph for Subbasin "Lucini_o_17S_base_aa"
Subbasin "Lucini_o_17S_base_aa" Results for Run "Lucini_o_17S_base_aa"
Depth (in)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
Flow (cfs)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan3000
Legend (Compute Time: 30Aug2016, 13:38:09)
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Precipitation
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Precipitation Loss
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Outflow
Run:Lucini_o_17S_base_aa Element:Lucini_o_17S_base_aa Result:Baseflow

Summary for Subcatchment 59S: Pro Aux 5

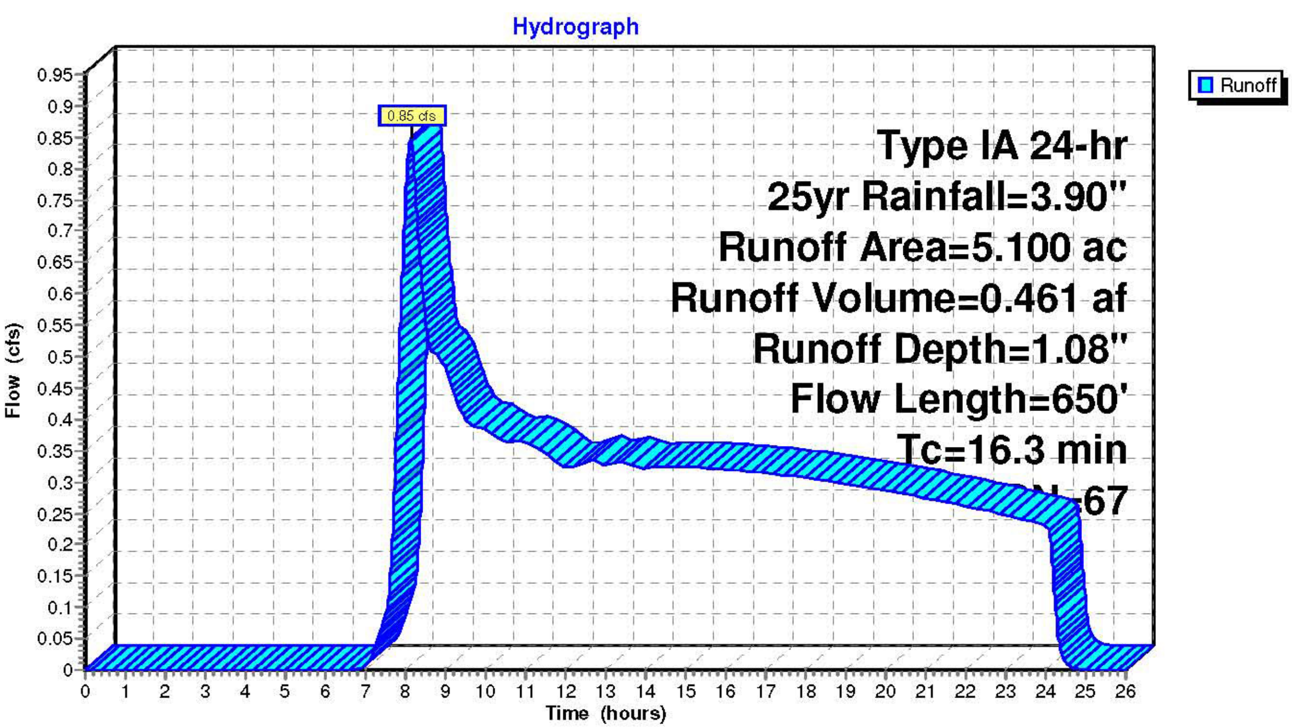
Runoff = 0.85 cfs @ 8.13 hrs, Volume= 0.461 af, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-26.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25yr Rainfall=3.90"

Area (ac)	CN	Description
3.800	65	2 acre lots, 12% imp, HSG B
1.300	74	Farmsteads, HSG B
5.100	67	Weighted Average
4.644		91.06% Pervious Area
0.456		8.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0100	0.09		**Sheet Flow, Field** Cultivated: Residue>20% n= 0.170 P2= 2.50"
6.5	500	0.0200	1.27		**Shallow Concentrated Flow, Field** Cultivated Straight Rows Kv= 9.0 fps
0.5	100	0.0400	3.22		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
16.3	650	Total			

Subcatchment 59S: Pro Aux 5



From County Storm Drainage Report for SW Boones Ferry Road (Jan 2013), PDF Page 101 of 152.

Table LU_b. IMPLEMENTED Subbasin Areas with Future Land Use Conditions

Weighted Curve Numbers used in HEC-HMS Hydrologic Modeling for Varying Land Use Cases

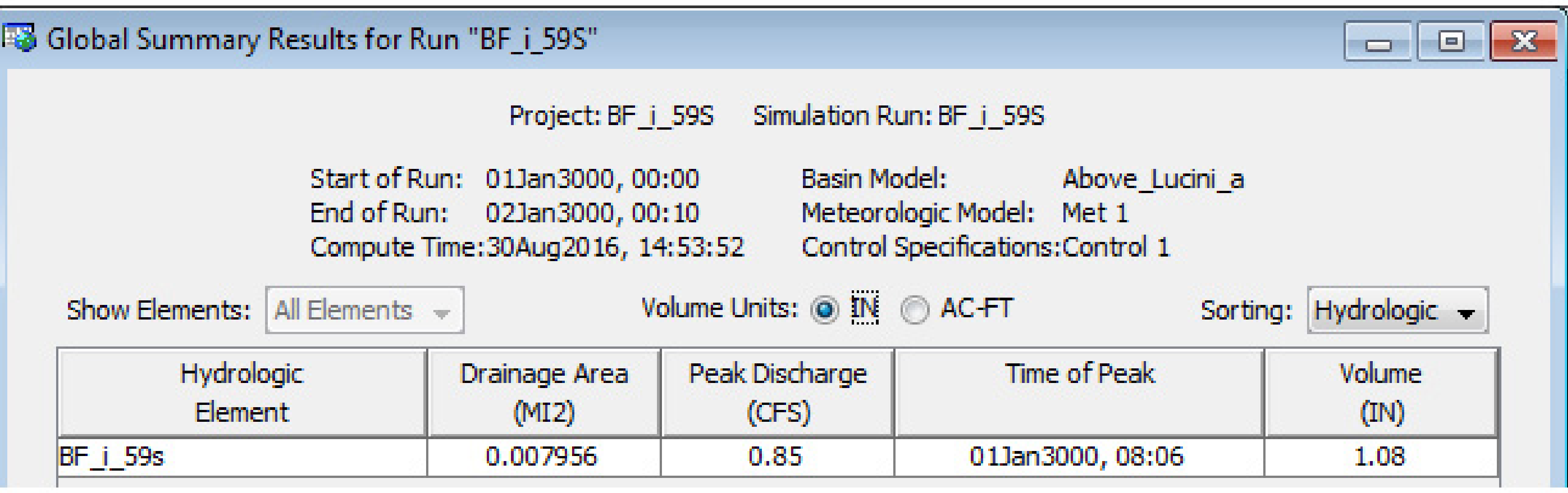
Weighted average CN Calculations

Inplemented On-going Land Use (LU)

Area (ac)	CN	Description		
1.9	65	2 acre lot, 12% imp., HSG B		
1.9	92	Urban Districts: Commercial and Business		
1.3	74	Farmsteads, HSG B		LU Case CN
5.1	77.4	Weighted Average	Weighted Average CN	77.4

Implemented, Full Build-out (BO)

Area (ac)	CN	Description		
1.9	85	2 acre lot, 12% imp., HSG B		
1.9	92	Urban Districts: Commercial and Business		
1.3	85	Residential Districts: 1/8 acre		BO Case CN
5.1	87.6	Weighted Average	Weighted Average CN	87.6



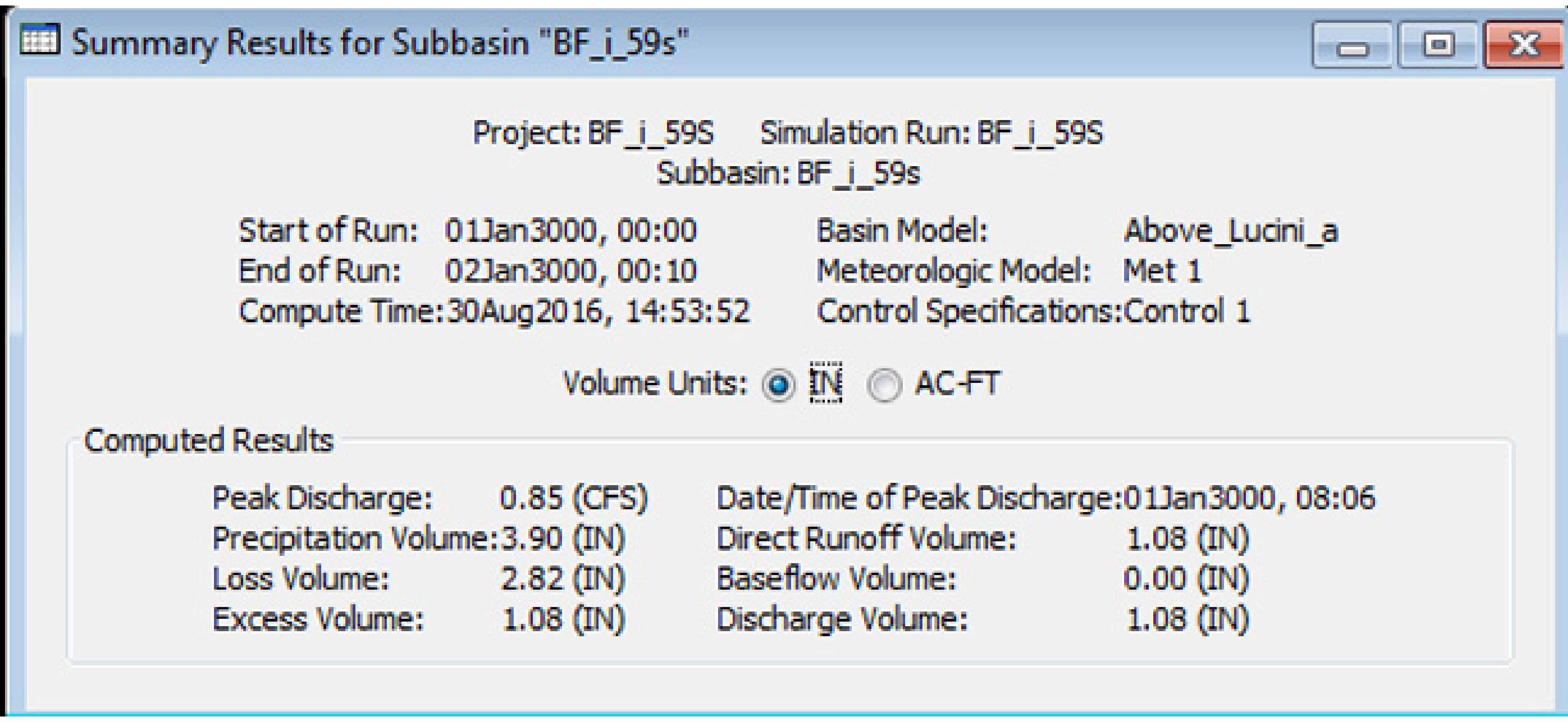
Global Summary Results for Run "BF_i_59S"

Project: BF_i_59S   Simulation Run: BF_i_59S

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 14:53:52   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: IN AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
BF_i_59s	0.007956	0.85	01Jan3000, 08:06	1.08



Summary Results for Subbasin "BF_i_59s"

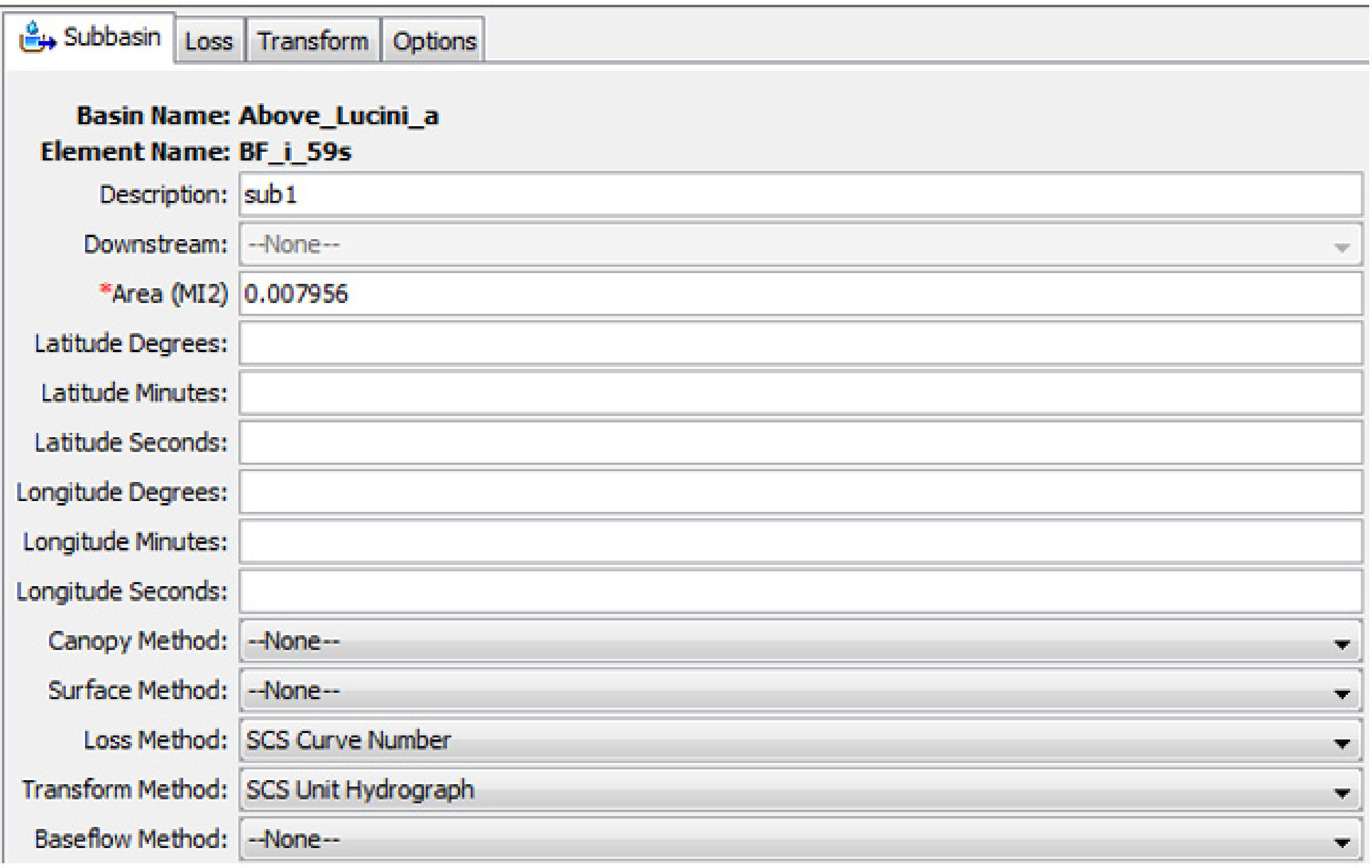
Project: BF_i_59S   Simulation Run: BF_i_59S
Subbasin: BF_i_59s

Start of Run: 01Jan3000, 00:00   Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 00:10   Meteorologic Model: Met 1
Compute Time: 30Aug2016, 14:53:52   Control Specifications: Control 1

Volume Units: IN AC-FT

Computed Results

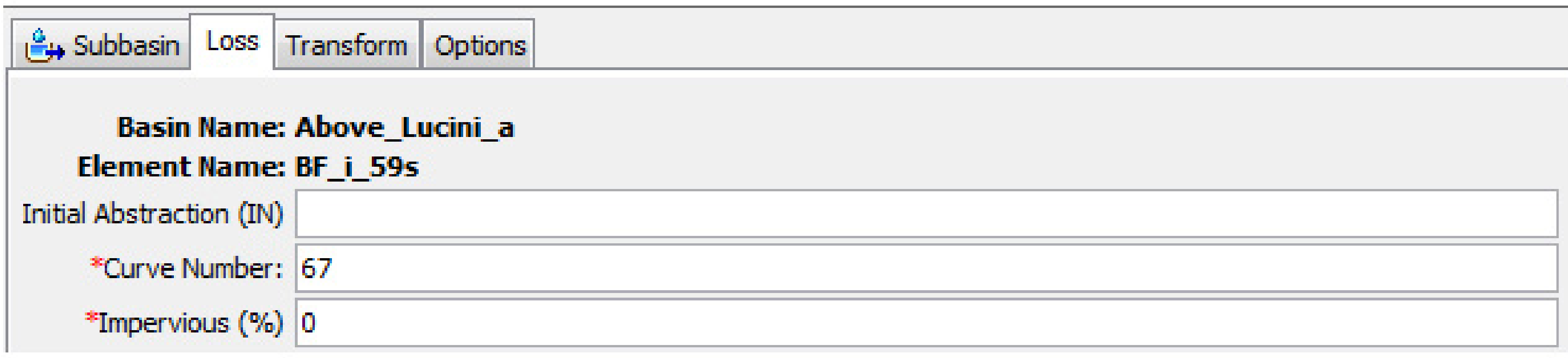
Peak Discharge: 0.85 (CFS)   Date/Time of Peak Discharge: 01Jan3000, 08:06
Precipitation Volume: 3.90 (IN)   Direct Runoff Volume: 1.08 (IN)
Loss Volume: 2.82 (IN)   Baseflow Volume: 0.00 (IN)
Excess Volume: 1.08 (IN)   Discharge Volume: 1.08 (IN)

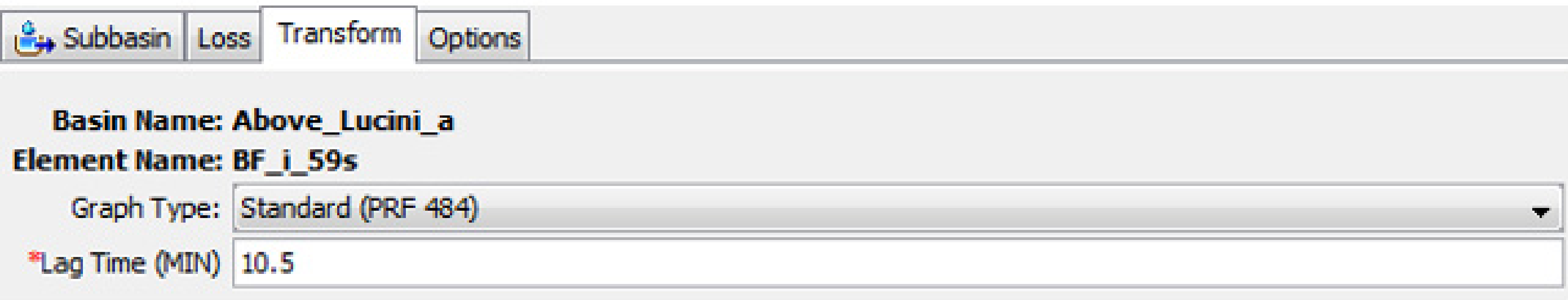


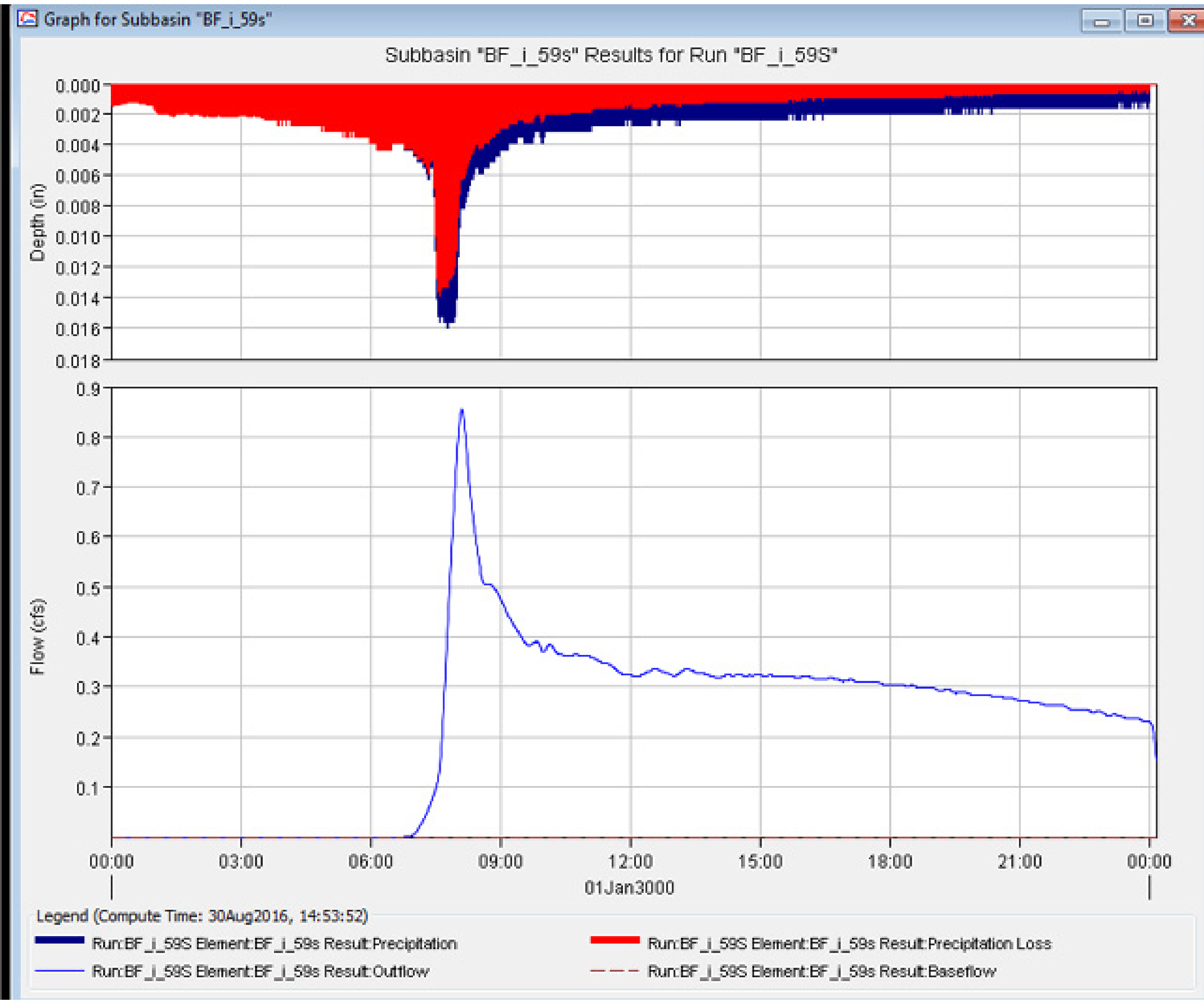
Subbasin | Loss | Transform | Options

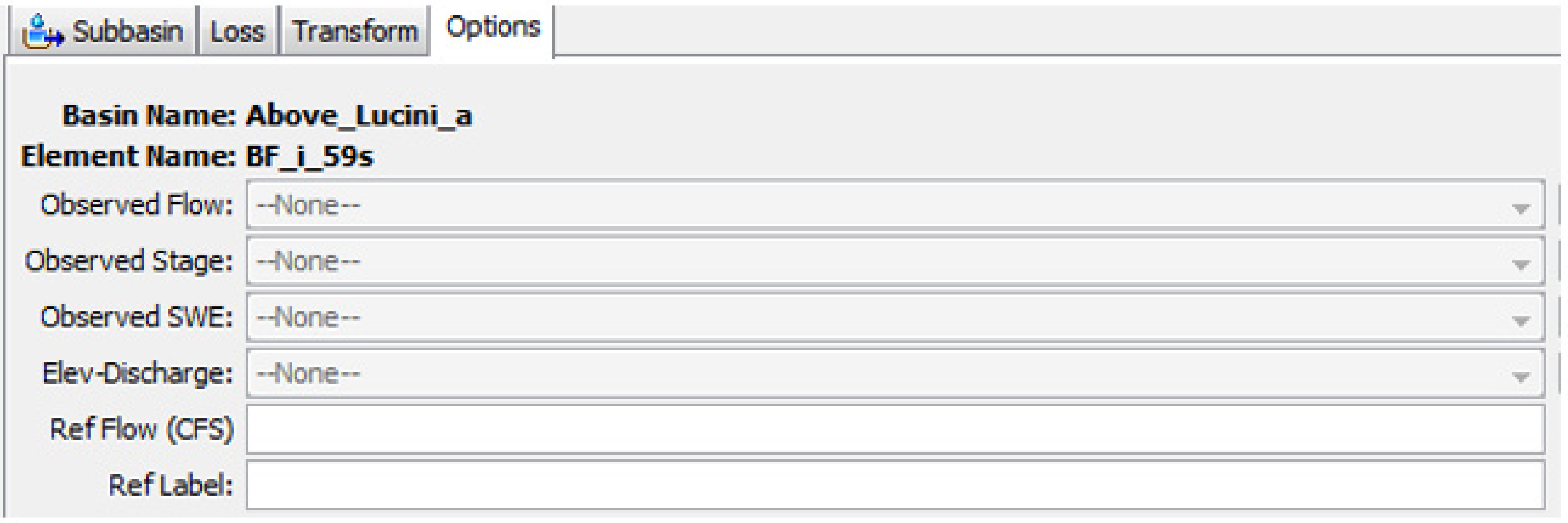
Basin Name: Above_Lucini_a
Element Name: BF_i_59s

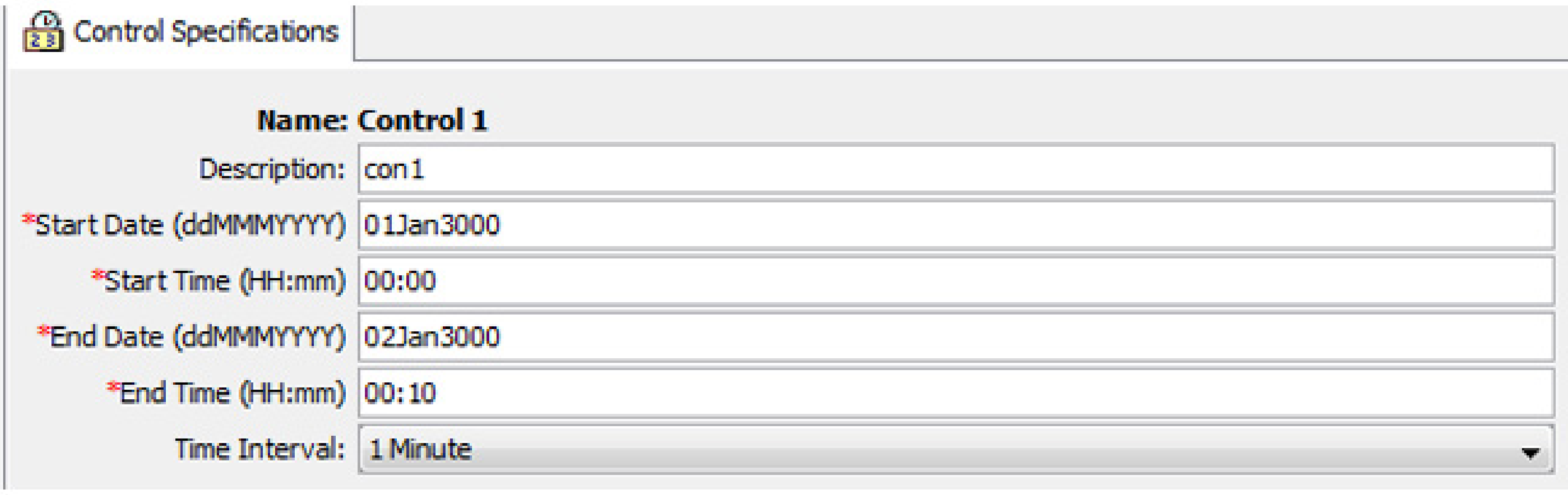
Description: sub1
Downstream: --None--
*Area (MI2) 0.007956
Latitude Degrees:
Latitude Minutes:
Latitude Seconds:
Longitude Degrees:
Longitude Minutes:
Longitude Seconds:
Canopy Method: --None--
Surface Method: --None--
Loss Method: SCS Curve Number
Transform Method: SCS Unit Hydrograph
Baseflow Method: --None--


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s
Initial Abstraction (IN)
*Curve Number: 67
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 10.5


Graph for Subbasin "BF_i_59s"
Subbasin "BF_i_59s" Results for Run "BF_i_59S"
Depth (in)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
Flow (cfs)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan3000
Legend (Compute Time: 30Aug2016, 14:53:52)
Run:BF_i_59S Element:BF_i_59s Result:Precipitation
Run:BF_i_59S Element:BF_i_59s Result:Precipitation Loss
Run:BF_i_59S Element:BF_i_59s Result:Outflow
Run:BF_i_59S Element:BF_i_59s Result:Baseflow


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s
Observed Flow: --None--
Observed Stage: --None--
Observed SWE: --None--
Elev-Discharge: --None--
Ref Flow (CFS)
Ref Label:


Control Specifications
Name: Control 1
Description: con1
*Start Date (ddMMMYYYY) 01Jan3000
*Start Time (HH:mm) 00:00
*End Date (ddMMMYYYY) 02Jan3000
*End Time (HH:mm) 00:10
Time Interval: 1 Minute

Global Summary Results for Run "BF_i_59S_base_b"

Project: BF_i_59S_base_b Simulation Run: BF_i_59S_base_b

Start of Run: 01Jan3000, 00:01 Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 12:01 Meteorologic Model: Met 1
Compute Time: 26Aug2016, 10:50:41 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
BF_i_59s_base_b	0.005967	0.64	01Jan3000, 08:07	1.08

Summary Results for Subbasin "BF_i_59s_base_b"

Project: BF_i_59S_base_b Simulation Run: BF_i_59S_base_b
Subbasin: BF_i_59s_base_b

Start of Run: 01Jan3000, 00:01 Basin Model: Above_Lucini_a
End of Run: 02Jan3000, 12:01 Meteorologic Model: Met 1
Compute Time: 30Aug2016, 11:28:16 Control Specifications: Control 1

Volume Units: IN AC-FT

Computed Results

Peak Discharge:	0.64 (CFS)	Date/Time of Peak Discharge:	01Jan3000, 08:07
Precipitation Volume:	3.90 (IN)	Direct Runoff Volume:	1.08 (IN)
Loss Volume:	2.82 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	1.08 (IN)	Discharge Volume:	1.08 (IN)

Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: BF_i_59s_base_b

Description:	sub1
Downstream:	--None--
*Area (MI2)	0.005967
Latitude Degrees:	
Latitude Minutes:	
Latitude Seconds:	
Longitude Degrees:	
Longitude Minutes:	
Longitude Seconds:	
Canopy Method:	--None--
Surface Method:	--None--
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	--None--

Subbasin | Loss | Transform | Options

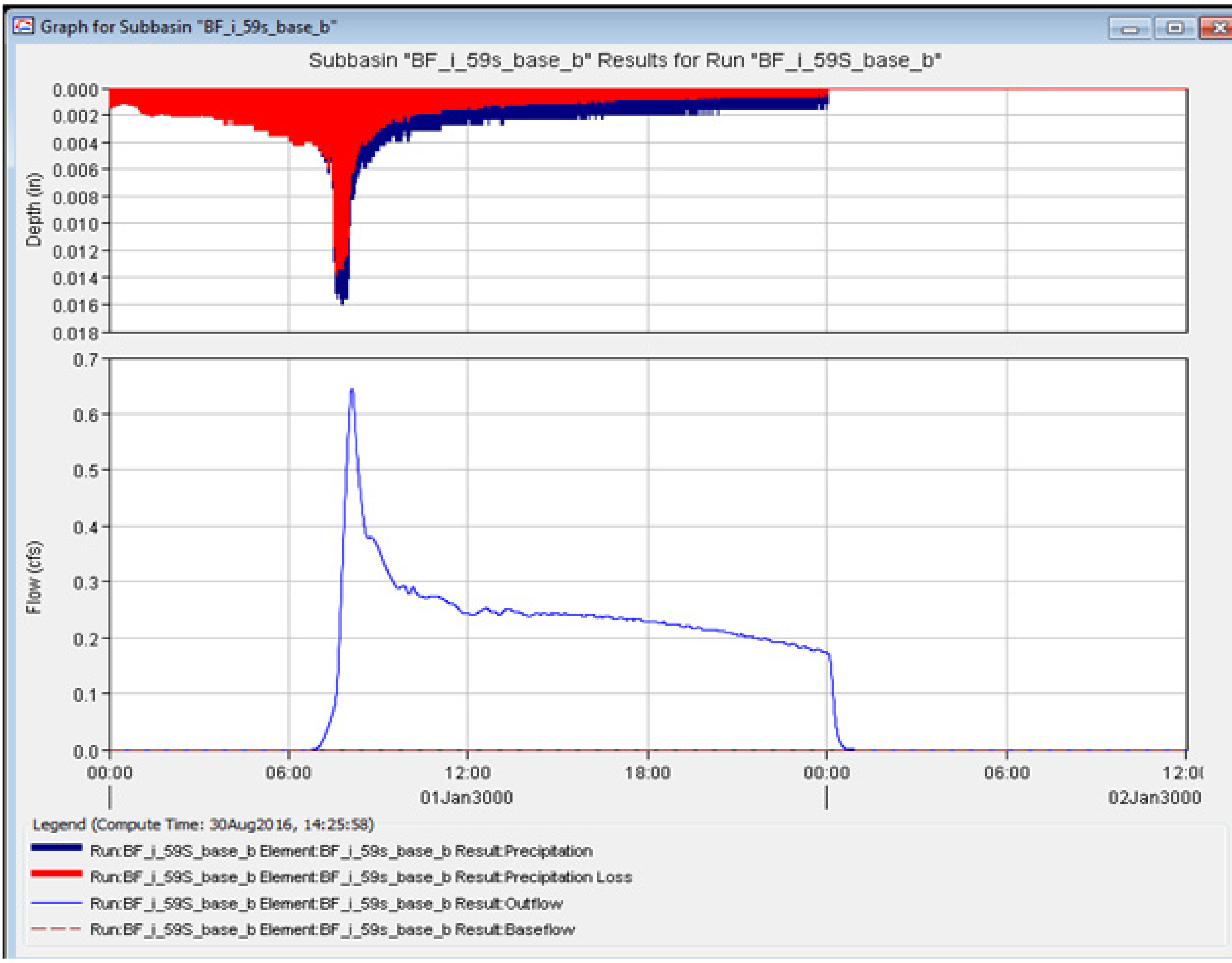
Basin Name: Above_Lucini_a
Element Name: BF_i_59s_base_b

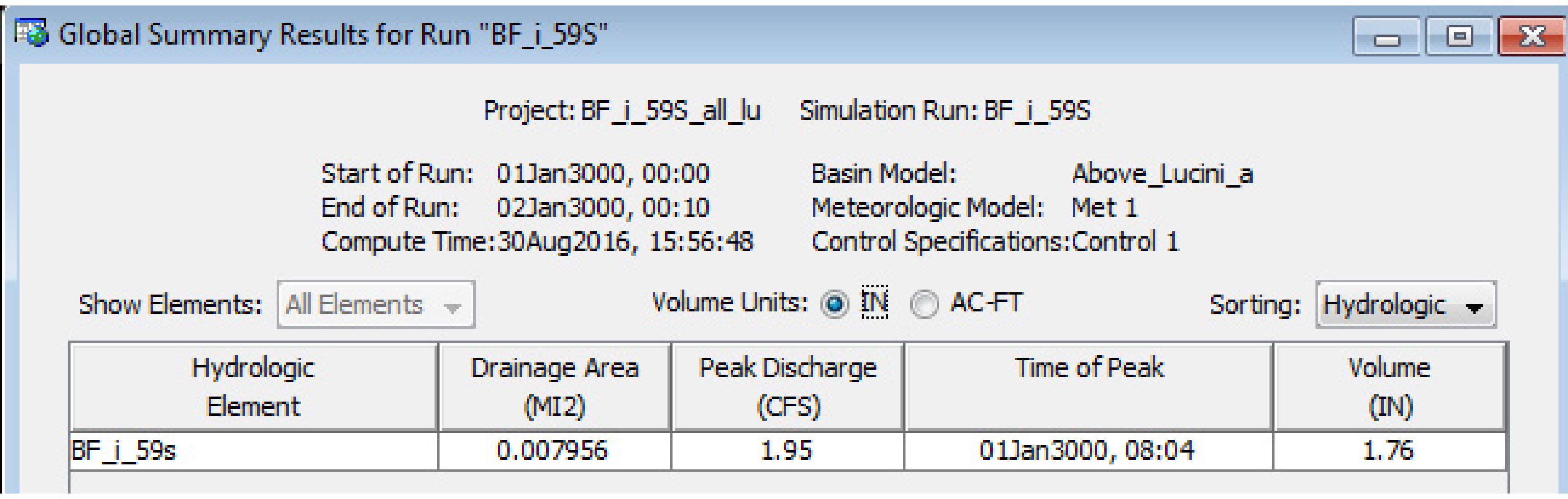
Initial Abstraction (IN)	
*Curve Number:	67
*Impervious (%)	0

Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: BF_i_59s_base_b

Graph Type:	Standard (PRF 484)
*Lag Time (MIN)	10.2





Global Summary Results for Run "BF_i_59S"

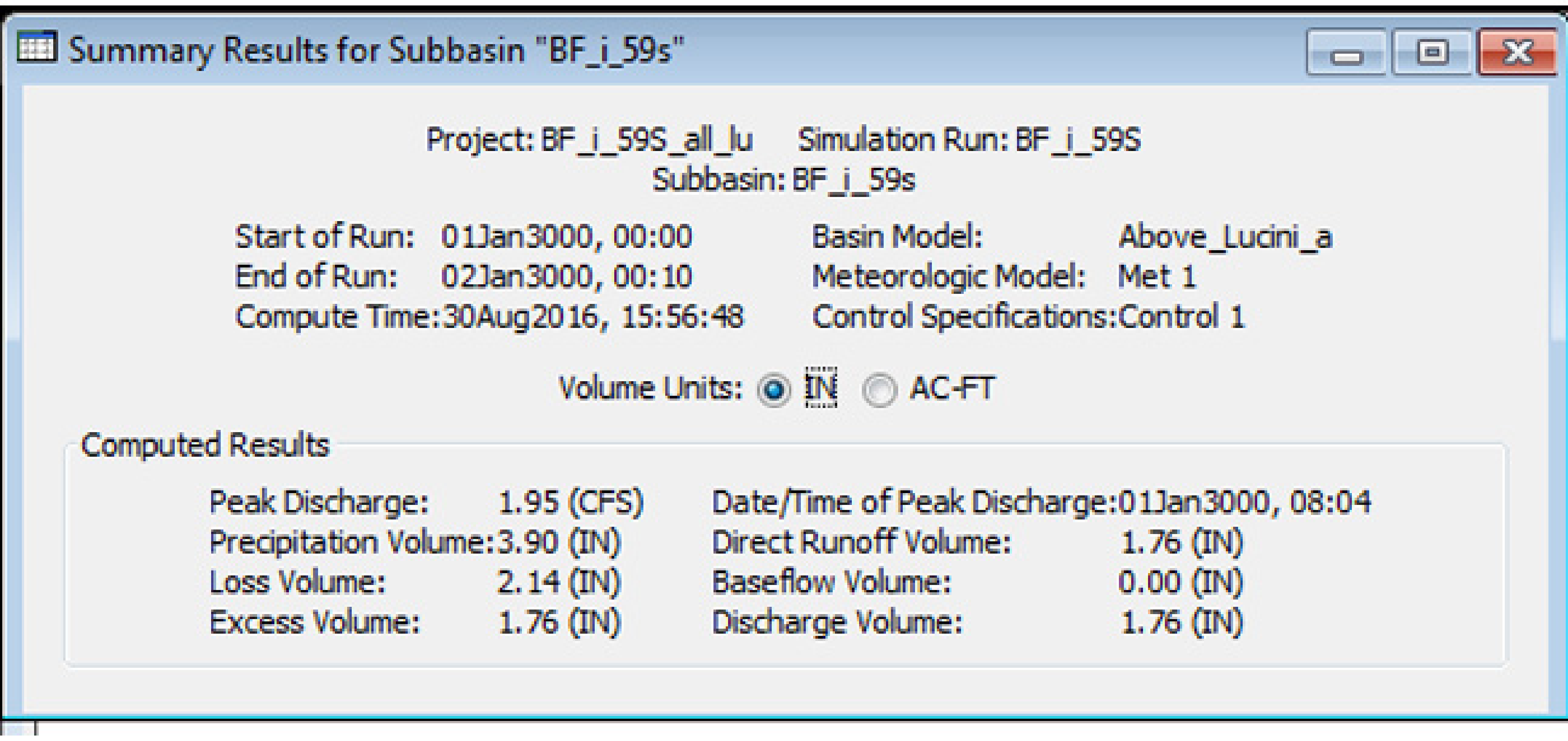
Project: BF_i_59S_all_lu Simulation Run: BF_i_59S

Start of Run: 01Jan3000, 00:00
End of Run: 02Jan3000, 00:10
Compute Time: 30Aug2016, 15:56:48

Basin Model: Above_Lucini_a
Meteorologic Model: Met 1
Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
BF_i_59s	0.007956	1.95	01Jan3000, 08:04	1.76



Summary Results for Subbasin "BF_i_59s"

Project: BF_i_59S_all_lu Simulation Run: BF_i_59S
Subbasin: BF_i_59s

Start of Run: 01Jan3000, 00:00
End of Run: 02Jan3000, 00:10
Compute Time: 30Aug2016, 15:56:48

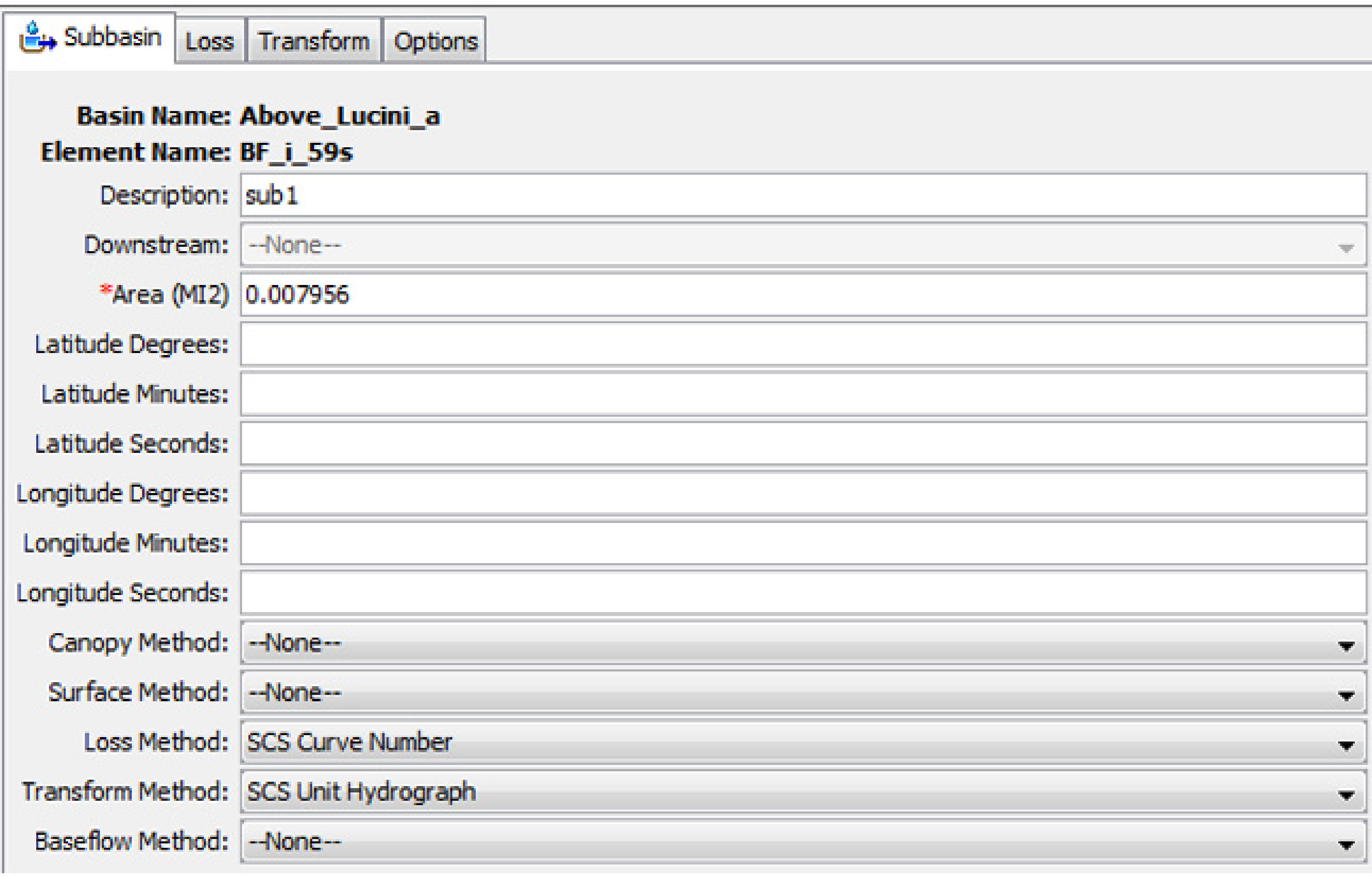
Basin Model: Above_Lucini_a
Meteorologic Model: Met 1
Control Specifications: Control 1

Volume Units: IN AC-FT

Computed Results

Peak Discharge: 1.95 (CFS)
Precipitation Volume: 3.90 (IN)
Loss Volume: 2.14 (IN)
Excess Volume: 1.76 (IN)

Date/Time of Peak Discharge: 01Jan3000, 08:04
Direct Runoff Volume: 1.76 (IN)
Baseflow Volume: 0.00 (IN)
Discharge Volume: 1.76 (IN)



Subbasin | Loss | Transform | Options

Basin Name: Above_Lucini_a
Element Name: BF_i_59s

Description: sub1
Downstream: --None--
*Area (MI2) 0.007956
Latitude Degrees:
Latitude Minutes:
Latitude Seconds:
Longitude Degrees:
Longitude Minutes:
Longitude Seconds:
Canopy Method: --None--
Surface Method: --None--
Loss Method: SCS Curve Number
Transform Method: SCS Unit Hydrograph
Baseflow Method: --None--

Subbasin | **Loss** | Transform | Options

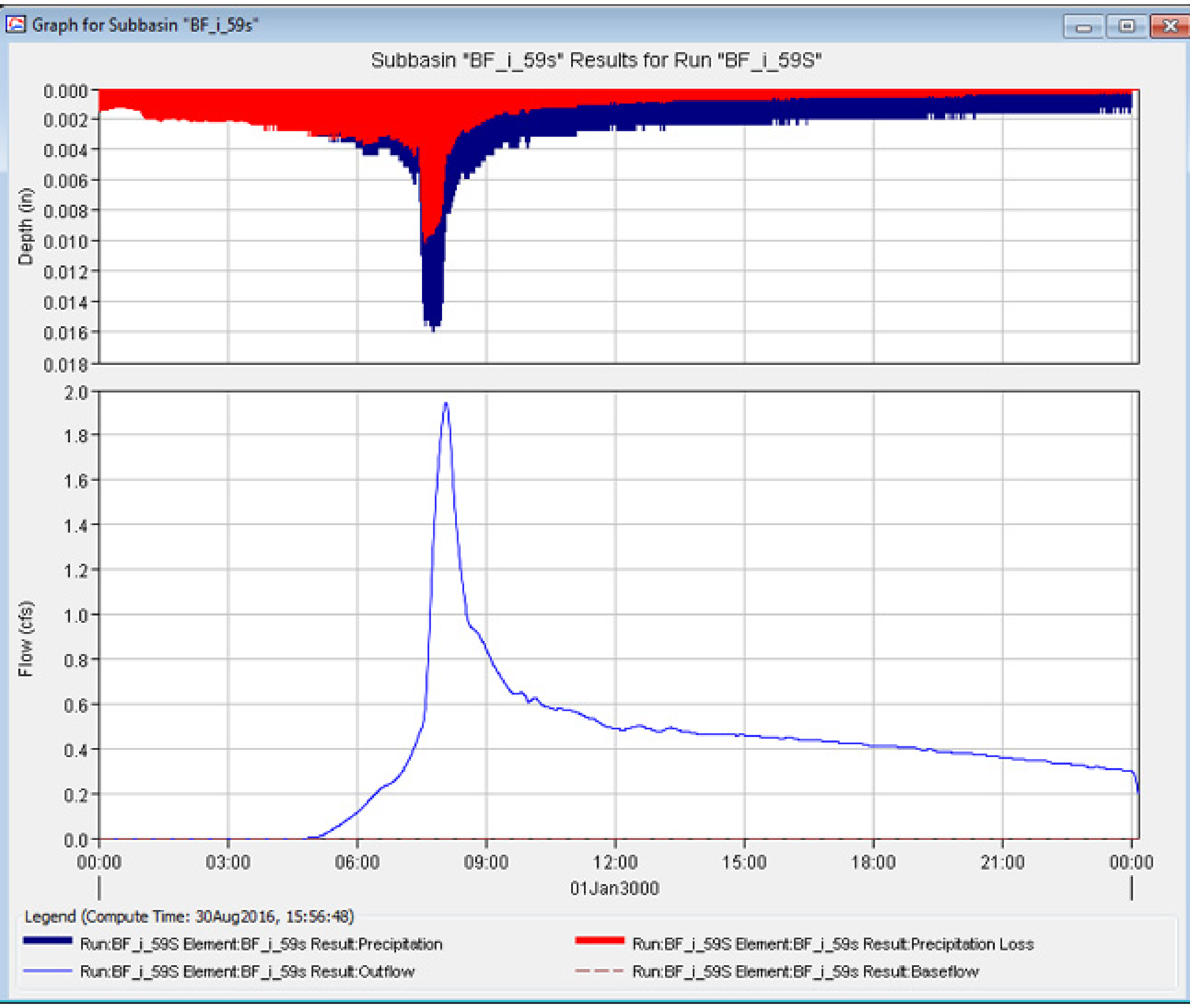
Basin Name: Above_Lucini_a
Element Name: BF_i_59s

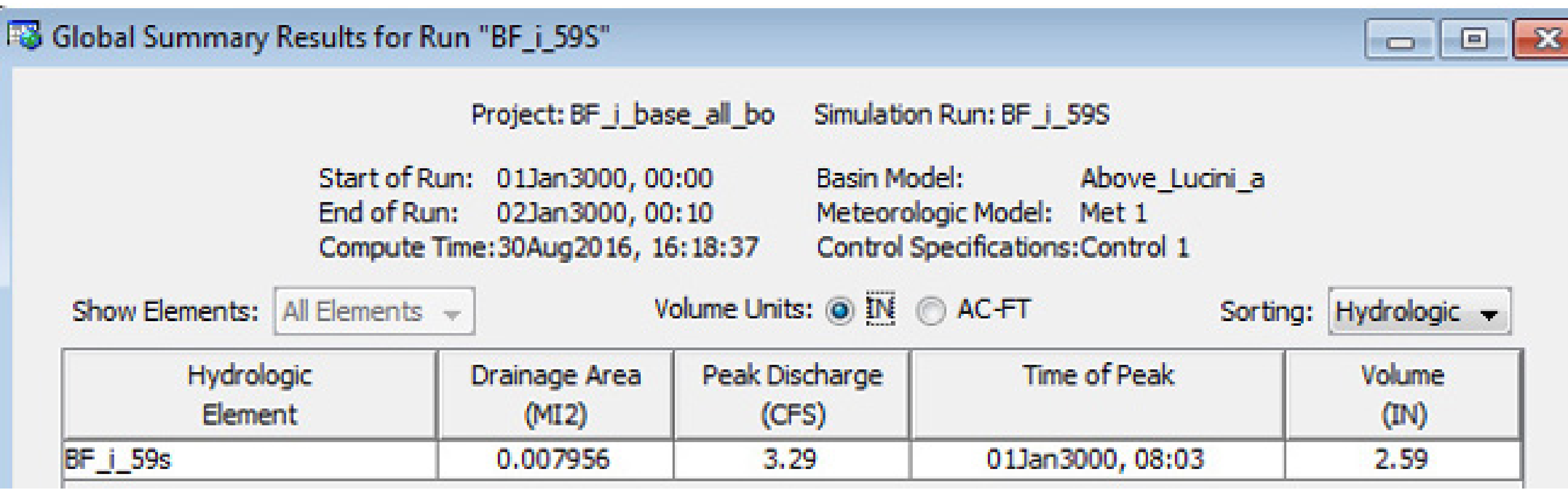
Initial Abstraction (IN):
*Curve Number: 77.4
*Impervious (%) 0

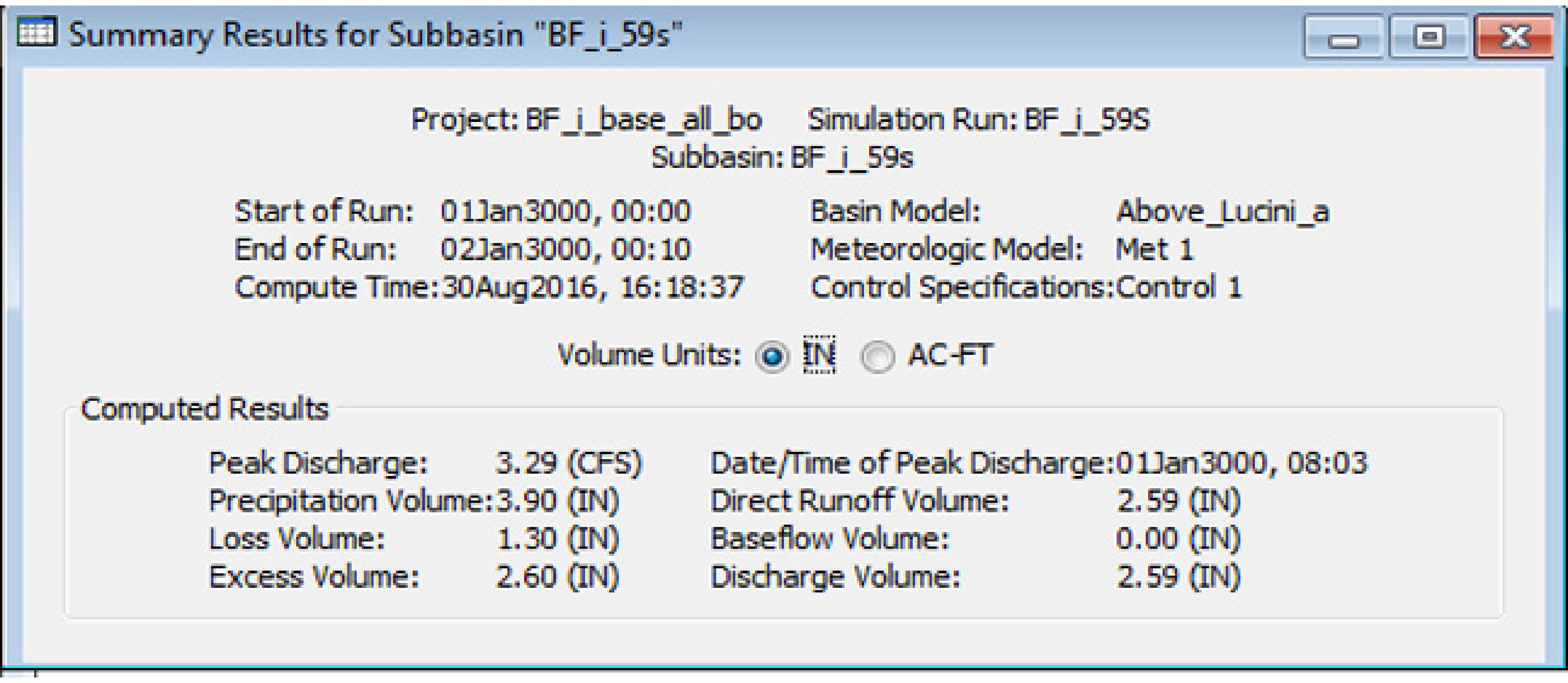
Subbasin | Loss | **Transform** | Options

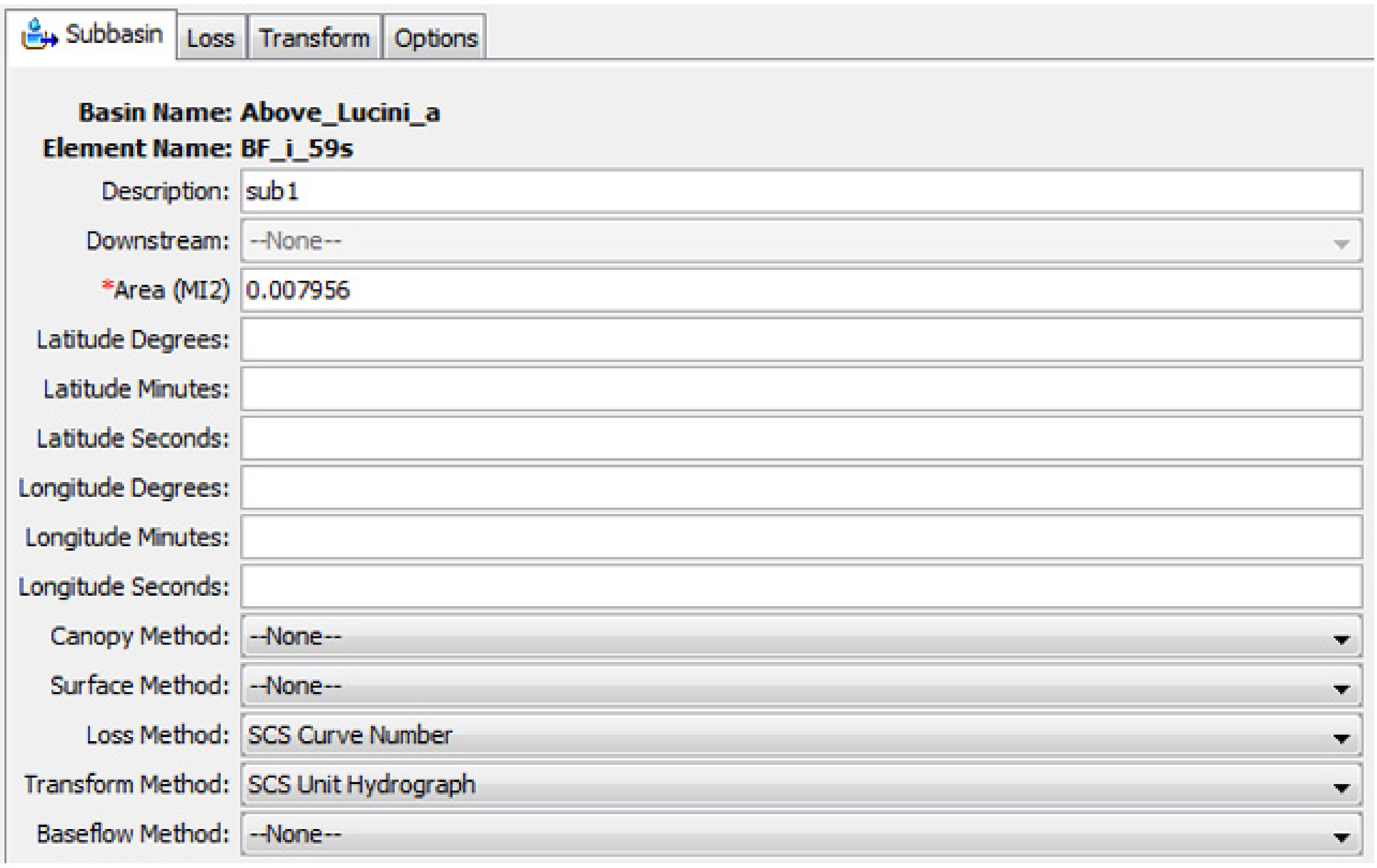
Basin Name: Above_Lucini_a
Element Name: BF_i_59s

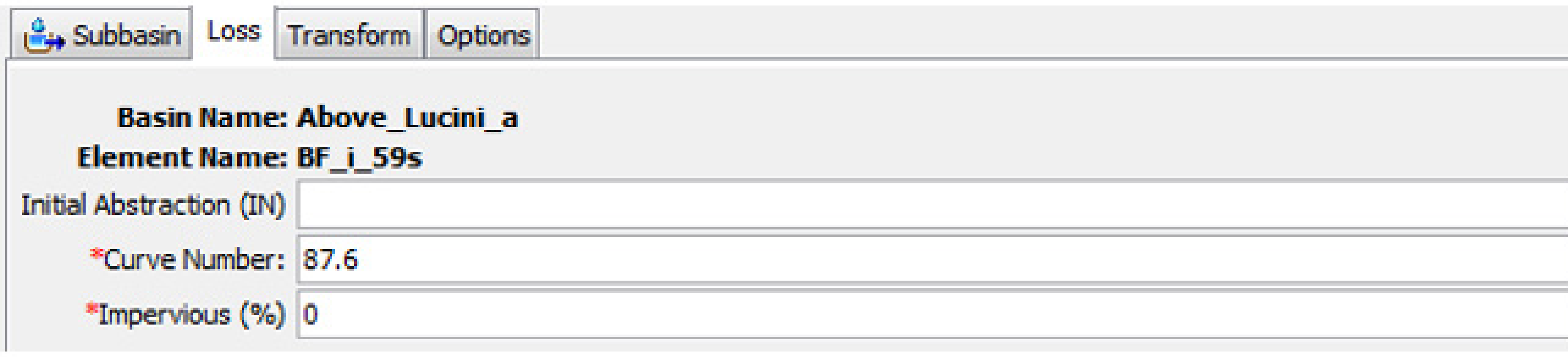
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 10.5

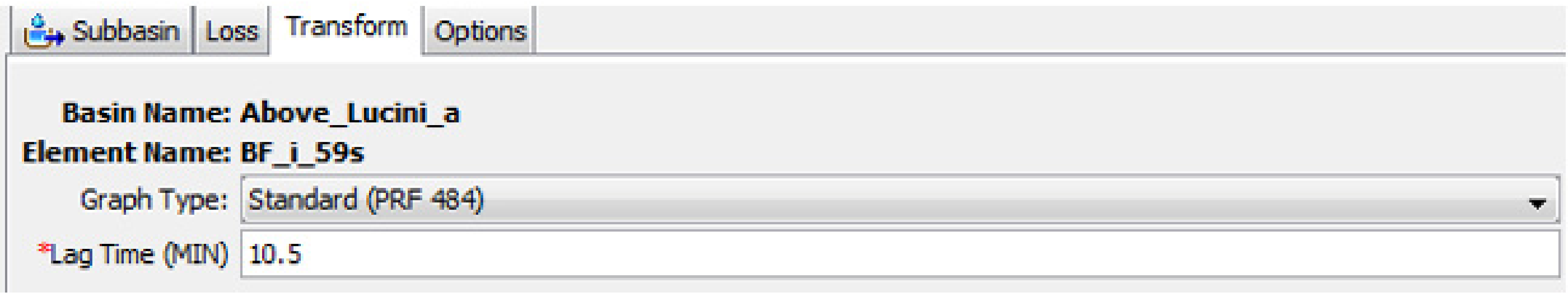


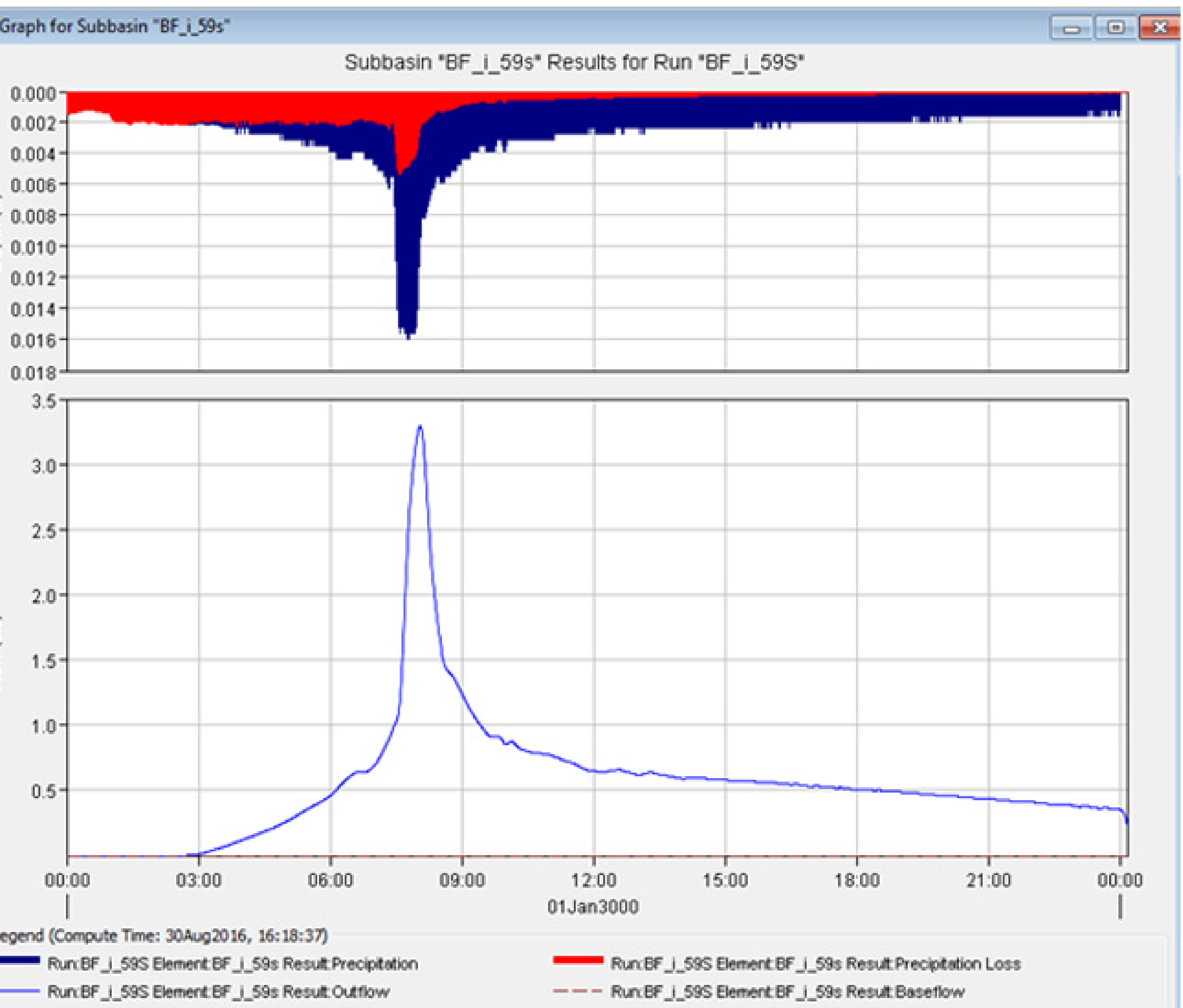

Global Summary Results for Run "BF_i_59S"
Project: BF_i_base_all_bo Simulation Run: BF_i_59S
Start of Run: 01Jan3000, 00:00
End of Run: 02Jan3000, 00:10
Compute Time: 30Aug2016, 16:18:37
Basin Model: Above_Lucini_a
Meteorologic Model: Met 1
Control Specifications: Control 1
Show Elements: All Elements
Volume Units: IN AC-FT
Sorting: Hydrologic
Hydrologic Element
Drainage Area (MI2)
Peak Discharge (CFS)
Time of Peak
Volume (IN)
BF_i_59s
0.007956
3.29
01Jan3000, 08:03
2.59


Summary Results for Subbasin "BF_i_59s"
Project: BF_i_base_all_bo Simulation Run: BF_i_59S
Subbasin: BF_i_59s
Start of Run: 01Jan3000, 00:00
End of Run: 02Jan3000, 00:10
Compute Time: 30Aug2016, 16:18:37
Basin Model: Above_Lucini_a
Meteorologic Model: Met 1
Control Specifications: Control 1
Volume Units: IN AC-FT
Computed Results
Peak Discharge: 3.29 (CFS)
Precipitation Volume: 3.90 (IN)
Loss Volume: 1.30 (IN)
Excess Volume: 2.60 (IN)
Date/Time of Peak Discharge: 01Jan3000, 08:03
Direct Runoff Volume: 2.59 (IN)
Baseflow Volume: 0.00 (IN)
Discharge Volume: 2.59 (IN)


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s
Description: sub1
Downstream: --None--
*Area (MI2) 0.007956
Latitude Degrees:
Latitude Minutes:
Latitude Seconds:
Longitude Degrees:
Longitude Minutes:
Longitude Seconds:
Canopy Method: --None--
Surface Method: --None--
Loss Method: SCS Curve Number
Transform Method: SCS Unit Hydrograph
Baseflow Method: --None--

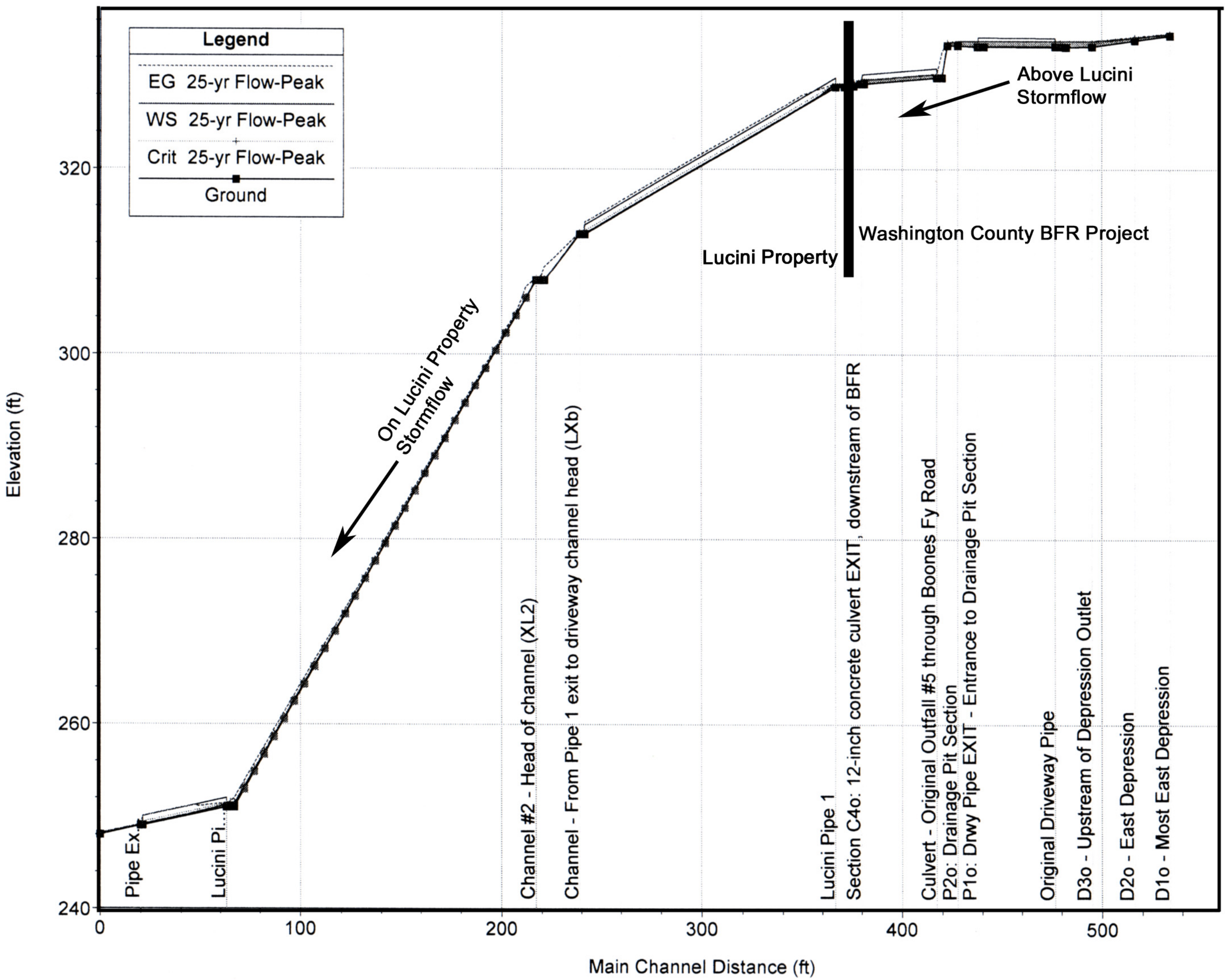

Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s
Initial Abstraction (IN)
*Curve Number: 87.6
*Impervious (%) 0


Subbasin
Loss
Transform
Options
Basin Name: Above_Lucini_a
Element Name: BF_i_59s
Graph Type: Standard (PRF 484)
*Lag Time (MIN) 10.5


Graph for Subbasin "BF_i_59s"
Subbasin "BF_i_59s" Results for Run "BF_i_59S"
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
3.5
3.0
2.5
2.0
1.5
1.0
0.5
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan3000
egend (Compute Time: 30Aug2016, 16:18:37)
Run:BF_i_59S Element:BF_i_59s Result:Precipitation
Run:BF_i_59S Element:BF_i_59s Result:Precipitation Loss
Run:BF_i_59S Element:BF_i_59s Result:Outflow
Run:BF_i_59S Element:BF_i_59s Result:Baseflow

Appendix I

Figure I-1. HEC-RAS Hydraulic Profile of ORIGINAL Pipe and Ditch Conditions at 0.89 cfs
Above and On the Lucini Property



Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: Cor_Orig 0.89cfs River: Above Lucini Reach: o_17S Profile: 25-yr Flow-Peak

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
o_17S	160.2	25-yr Flow-Peak	0.89	334.50	334.76	334.68	334.77	0.011532	0.91	0.98	7.60	0.44
o_17S	142.4	25-yr Flow-Peak	0.89	334.00	334.30	334.30	334.38	0.056691	2.20	0.40	2.67	0.99
o_17S	121.3	25-yr Flow-Peak	0.89	333.30	333.96	333.67	333.97	0.002925	0.81	1.10	3.37	0.25
o_17S	108.4	25-yr Flow-Peak	0.89	333.24	333.93		333.93	0.001875	0.62	1.44	4.44	0.19
o_17S	105.7	25-yr Flow-Peak	0.89	333.30	333.91	333.67	333.93	0.004143	0.92	0.97	3.16	0.29
o_17S	87.4		Culvert									
o_17S	66.4	25-yr Flow-Peak	0.89	333.28	333.92		333.92	0.000206	0.28	3.19	6.83	0.07
o_17S	56.6	25-yr Flow-Peak	0.89	333.40	333.90		333.91	0.006810	1.04	0.85	3.44	0.37
o_17S	51.5	25-yr Flow-Peak	0.89	333.40	333.73	333.73	333.82	0.056356	2.31	0.39	2.31	1.00
o_17S	48.8	25-yr Flow-Peak	0.89	329.94	329.97	330.09	332.61	1.800609	13.05	0.07	2.70	14.46
o_17S	28.6		Culvert									
o_17S	8.8	25-yr Flow-Peak	0.89	329.27	329.68	329.68	329.79	0.057239	2.57	0.35	1.67	1.00
o_17S	4.8	25-yr Flow-Peak	0.89	329.00	329.42	329.37	329.47	0.027824	1.86	0.48	2.30	0.72
o_17S	0.00	25-yr Flow-Peak	0.89	328.92	329.20	329.20	329.28	0.059737	2.16	0.41	2.89	1.01
o_17S	-65		Culvert									
o_17S	-130	25-yr Flow-Peak	0.89	313.00	313.20		313.22	0.009717	1.04	0.85	4.60	0.43
o_17S	-132	25-yr Flow-Peak	0.89	313.00	313.11	313.11	313.17	0.067286	1.91	0.47	4.33	1.03
o_17S	-150	25-yr Flow-Peak	0.89	308.00	308.03	308.11	309.03	7.363283	8.05	0.11	4.08	8.63
o_17S	-152	25-yr Flow-Peak	0.89	308.00	308.22	308.13	308.24	0.009842	1.04	0.85	4.67	0.43
o_17S	-154	25-yr Flow-Peak	0.89	308.00	308.13	308.13	308.19	0.098000	1.97	0.45	3.97	1.03
o_17S	-302	25-yr Flow-Peak	0.89	251.00	251.35	251.48	251.80	0.375062	5.44	0.16	0.95	2.31
o_17S	-304	25-yr Flow-Peak	0.89	251.00	251.48	251.48	251.60	0.062529	2.78	0.32	1.33	1.00
o_17S	-326.5		Culvert									
o_17S	-349	25-yr Flow-Peak	0.89	249.00	249.07	249.07	249.12	0.086052	1.65	0.54	7.66	1.09
o_17S	-369	25-yr Flow-Peak	0.89	248.00	248.17	248.09	248.18	0.010007	0.92	0.97	6.51	0.42

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: Err_Orig 1.17cfs River: Above Lucini Reach: o_17S Profile: 25-yr Flow-Peak

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
o_17S	160.2	25-yr Flow-Peak	1.17	334.50	334.79	334.71	334.80	0.011156	0.96	1.22	8.48	0.44
o_17S	142.4	25-yr Flow-Peak	1.17	334.00	334.34	334.34	334.42	0.054613	2.32	0.50	2.98	0.99
o_17S	121.3	25-yr Flow-Peak	1.17	333.30	334.02	333.72	334.03	0.003334	0.88	1.32	3.89	0.27
o_17S	108.4	25-yr Flow-Peak	1.17	333.24	333.99		333.99	0.002252	0.68	1.72	5.31	0.21
o_17S	105.7	25-yr Flow-Peak	1.17	333.30	333.97	333.72	333.98	0.004599	1.02	1.14	3.43	0.31
o_17S	87.4		Culvert									
o_17S	66.4	25-yr Flow-Peak	1.17	333.28	333.98		333.98	0.000257	0.33	3.57	7.09	0.08
o_17S	56.6	25-yr Flow-Peak	1.17	333.40	333.95		333.97	0.006985	1.13	1.04	3.79	0.38
o_17S	51.5	25-yr Flow-Peak	1.17	333.40	333.77	333.77	333.86	0.054365	2.44	0.48	2.58	1.00
o_17S	48.8	25-yr Flow-Peak	1.17	329.94	329.97	330.12	332.68	1.308928	13.20	0.09	2.70	12.83
o_17S	28.6		Culvert									
o_17S	8.8	25-yr Flow-Peak	1.17	329.27	329.73	329.73	329.85	0.057477	2.76	0.42	1.85	1.01
o_17S	4.8	25-yr Flow-Peak	1.17	329.00	329.36	329.41	329.53	0.105970	3.29	0.36	1.98	1.37
o_17S	0.00	25-yr Flow-Peak	1.17	328.92	329.24	329.24	329.32	0.056489	2.27	0.52	3.24	1.00
o_17S	-65		Culvert									
o_17S	-130	25-yr Flow-Peak	1.17	313.00	313.23		313.25	0.010699	1.19	0.99	4.68	0.45
o_17S	-132	25-yr Flow-Peak	1.17	313.00	313.12	313.13	313.20	0.088360	2.31	0.51	4.36	1.19
o_17S	-150	25-yr Flow-Peak	1.17	308.00	308.05	308.14	308.67	2.370216	6.36	0.18	4.14	5.31
o_17S	-152	25-yr Flow-Peak	1.17	308.00	308.07	308.15	308.45	0.831842	4.94	0.24	3.54	3.37
o_17S	-154	25-yr Flow-Peak	1.17	308.00	308.15	308.15	308.22	0.091385	2.11	0.55	4.16	1.02
o_17S	-302	25-yr Flow-Peak	1.17	251.00	251.38	251.54	251.91	0.374716	5.82	0.20	1.05	2.35
o_17S	-304	25-yr Flow-Peak	1.17	251.00	251.54	251.54	251.67	0.060366	2.93	0.40	1.48	1.00
o_17S	-326.5		Culvert									
o_17S	-349	25-yr Flow-Peak	1.17	249.00	249.09	249.09	249.14	0.070877	1.72	0.68	7.83	1.03
o_17S	-369	25-yr Flow-Peak	1.17	248.00	248.20	248.11	248.21	0.010001	1.01	1.16	6.77	0.43

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: LU_Orig 1.71cfs River: Above Lucini Reach: o_17S Profile: 25-yr Flow-Peak

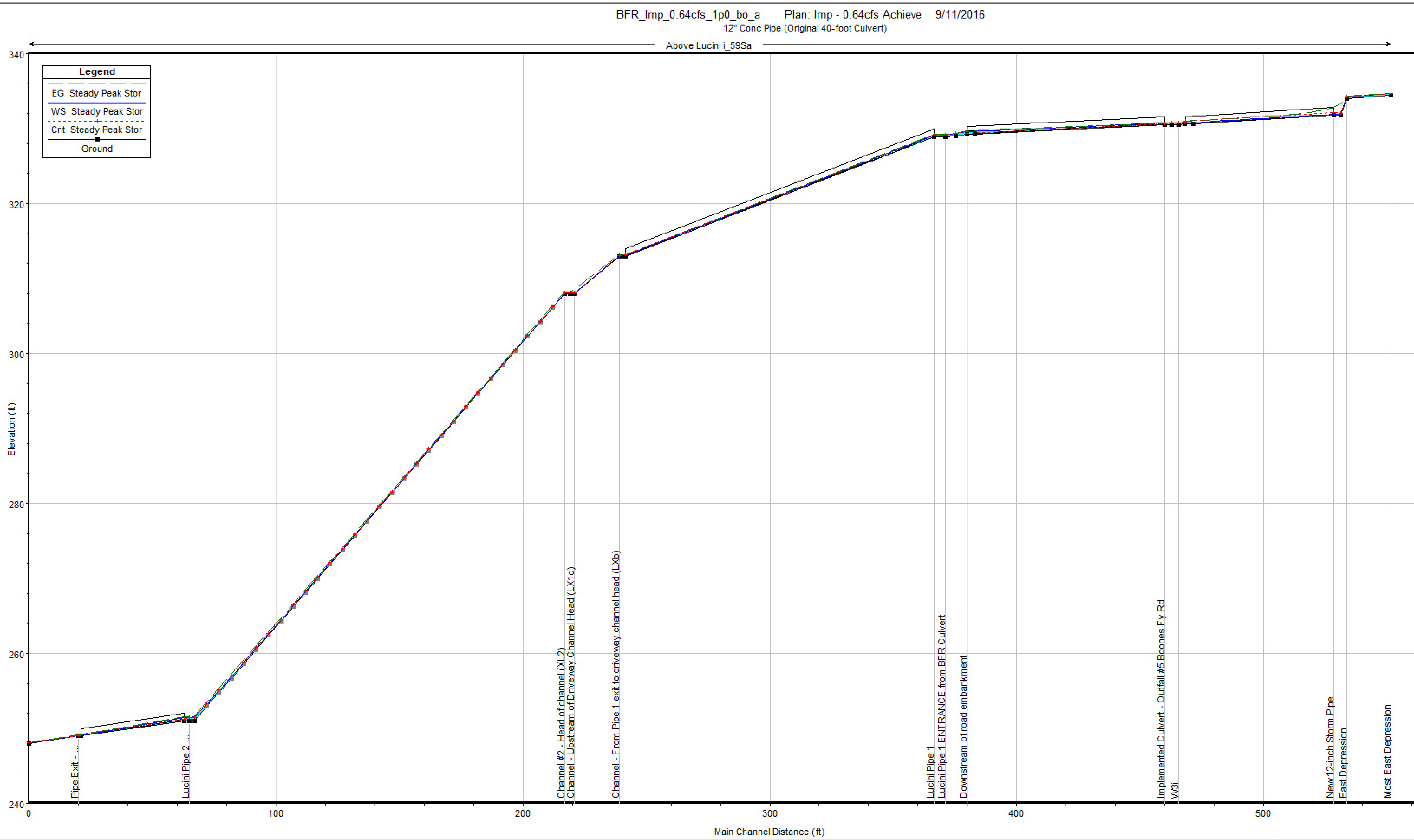
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
o_17S	160.2	25-yr Flow-Peak	1.71	334.50	334.84	334.74	334.85	0.010207	1.02	1.68	9.94	0.44
o_17S	142.4	25-yr Flow-Peak	1.71	334.00	334.39	334.39	334.49	0.054093	2.54	0.67	3.44	1.01
o_17S	121.3	25-yr Flow-Peak	1.71	333.30	334.11	333.79	334.13	0.004242	0.97	1.77	5.54	0.30
o_17S	108.4	25-yr Flow-Peak	1.71	333.24	334.07		334.08	0.002629	0.76	2.24	6.65	0.23
o_17S	105.7	25-yr Flow-Peak	1.71	333.30	334.05	333.79	334.07	0.006123	1.18	1.46	4.45	0.36
o_17S	87.4		Culvert									
o_17S	66.4	25-yr Flow-Peak	1.71	333.28	334.06		334.06	0.000351	0.41	4.18	7.48	0.10
o_17S	56.6	25-yr Flow-Peak	1.71	333.40	334.02		334.05	0.007513	1.28	1.34	4.31	0.40
o_17S	51.5	25-yr Flow-Peak	1.71	333.40	333.83	333.83	333.94	0.051589	2.63	0.65	3.00	0.99
o_17S	48.8	25-yr Flow-Peak	1.71	329.94	329.99	330.17	332.78	0.843351	13.41	0.13	2.70	10.87
o_17S	28.6		Culvert									
o_17S	8.8	25-yr Flow-Peak	1.71	329.27	329.80	329.80	329.94	0.054404	2.97	0.58	2.16	1.01
o_17S	4.8	25-yr Flow-Peak	1.71	329.00	329.41	329.47	329.62	0.113652	3.71	0.46	2.25	1.44
o_17S	0.00	25-yr Flow-Peak	1.71	328.92	329.29	329.29	329.38	0.052889	2.43	0.70	3.78	1.00
o_17S	-65		Culvert									
o_17S	-130	25-yr Flow-Peak	1.71	313.00	313.28		313.31	0.011691	1.40	1.23	4.83	0.49
o_17S	-132	25-yr Flow-Peak	1.71	313.00	313.16	313.17	313.26	0.078067	2.56	0.67	4.47	1.17
o_17S	-150	25-yr Flow-Peak	1.71	308.00	308.05	308.17	309.02	2.947858	7.88	0.22	4.16	6.07
o_17S	-152	25-yr Flow-Peak	1.71	308.00	308.31	308.20	308.33	0.011372	1.34	1.27	5.30	0.48
o_17S	-154	25-yr Flow-Peak	1.71	308.00	308.20	308.20	308.28	0.081682	2.31	0.74	4.49	1.00
o_17S	-302	25-yr Flow-Peak	1.71	251.00	251.44	251.62	252.08	0.375093	6.40	0.27	1.21	2.40
o_17S	-304	25-yr Flow-Peak	1.71	251.00	251.53	251.62	251.83	0.139144	4.41	0.39	1.46	1.51
o_17S	-326.5		Culvert									
o_17S	-349	25-yr Flow-Peak	1.71	249.00	249.12	249.12	249.18	0.061679	1.90	0.90	8.08	1.00
o_17S	-369	25-yr Flow-Peak	1.71	248.00	248.24	248.15	248.26	0.010004	1.15	1.49	7.20	0.45

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: BO_Orig 2.85cfs River: Above Lucini Reach: o_17S Profile: 25-yr Flow-Peak

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
o_17S	160.2	25-yr Flow-Peak	2.85	334.50	334.92	334.80	334.94	0.009158	1.11	2.57	12.28	0.43
o_17S	142.4	25-yr Flow-Peak	2.85	334.00	334.48	334.48	334.60	0.049261	2.79	1.02	4.24	1.00
o_17S	121.3	25-yr Flow-Peak	2.85	333.30	334.25	333.89	334.27	0.004561	1.06	2.70	7.96	0.32
o_17S	108.4	25-yr Flow-Peak	2.85	333.24	334.21		334.22	0.002898	0.87	3.27	8.71	0.25
o_17S	105.7	25-yr Flow-Peak	2.85	333.30	334.18	333.89	334.21	0.007433	1.30	2.19	6.73	0.40
o_17S	87.4		Culvert									
o_17S	66.4	25-yr Flow-Peak	2.85	333.28	334.19		334.20	0.000519	0.55	5.23	8.11	0.12
o_17S	56.6	25-yr Flow-Peak	2.85	333.40	334.14		334.18	0.008075	1.49	1.91	5.15	0.43
o_17S	51.5	25-yr Flow-Peak	2.85	333.40	333.93	333.93	334.06	0.050191	2.96	0.96	3.66	1.01
o_17S	48.8	25-yr Flow-Peak	2.85	329.94	330.02	330.27	332.92	0.469839	13.68	0.21	2.70	8.68
o_17S	28.6		Culvert									
o_17S	8.8	25-yr Flow-Peak	2.85	329.27	329.93	329.93	330.09	0.049951	3.27	0.87	2.66	1.00
o_17S	4.8	25-yr Flow-Peak	2.85	329.00	329.50	329.58	329.77	0.111470	4.18	0.68	2.74	1.48
o_17S	0.00	25-yr Flow-Peak	2.85	328.92	329.38	329.38	329.49	0.049294	2.69	1.06	4.64	0.99
o_17S	-65		Culvert									
o_17S	-130	25-yr Flow-Peak	2.85	313.00	313.36		313.41	0.013243	1.74	1.64	5.08	0.54
o_17S	-132	25-yr Flow-Peak	2.85	313.00	313.23	313.24	313.36	0.064030	2.89	0.98	4.68	1.11
o_17S	-150	25-yr Flow-Peak	2.85	308.00	308.07	308.24	309.65	3.452740	10.07	0.28	4.21	6.85
o_17S	-152	25-yr Flow-Peak	2.85	308.00	308.39	308.27	308.43	0.012447	1.62	1.76	5.95	0.52
o_17S	-154	25-yr Flow-Peak	2.85	308.00	308.27	308.27	308.38	0.076003	2.64	1.08	5.02	1.01
o_17S	-302	25-yr Flow-Peak	2.85	251.00	251.53	251.77	252.36	0.375560	7.28	0.39	1.47	2.48
o_17S	-304	25-yr Flow-Peak	2.85	251.00	251.74	251.77	251.96	0.064544	3.76	0.76	2.04	1.09
o_17S	-326.5		Culvert									
o_17S	-349	25-yr Flow-Peak	2.85	249.00	249.17	249.17	249.24	0.055550	2.21	1.29	8.50	1.00
o_17S	-369	25-yr Flow-Peak	2.85	248.00	248.33	248.20	248.35	0.010003	1.35	2.10	7.93	0.46



BFR_Imp_0.64cfs_1p0_bo_a Plan: Imp - 0.64cfs Achieve 9/11/2016
12" Conc Pipe (Original 40-foot Culvert)
Above Lucini i_59Sa
Legend
EG Steady Peak Stor
WS Steady Peak Stor
Crit Steady Peak Stor
Ground
Elevation (ft)
Main Channel Distance (ft)
Pipe Exit - ...
Lucini Pipe 2 ...
Channel #2 - Head of channel (XL2)
Channel - Upstream of Driveway Channel Head (LX1c)
Channel - From Pipe 1 exit to driveway channel head (LXb)
Lucini Pipe 1
Lucini Pipe 1 ENTRANCE from BFR Culvert
Downstream of road embankment
Implemented Culvert - Outfall #5 Boones Fy Rd
W3i
New 12-inch Storm Pipe
East Depression
Most East Depression

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: IMP 0.64cfs Ach River: Above Lucini Reach: i_59Sa Profile: Steady Peak Stor

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
i_59Sa	175.3	Steady Peak Stor	0.64	334.50	334.73	334.66	334.74	0.011869	0.84	0.76	6.68	0.44
i_59Sa	157.5	Steady Peak Stor	0.64	334.00	334.27	334.27	334.33	0.059196	2.06	0.31	2.34	0.99
i_59Sa	154.8	Steady Peak Stor	0.64	331.80	331.87	332.03	333.24	0.289235	9.41	0.07	1.00	6.36
i_59Sa	120		Culvert									
i_59Sa	94.5	Steady Peak Stor	0.64	330.60	330.75	330.75	330.82	0.005384	2.15	0.30	2.00	0.98
i_59Sa	91.8	Steady Peak Stor	0.64	330.55	330.75	330.70	330.79	0.002079	1.59	0.40	2.00	0.62
i_59Sa	89.1	Steady Peak Stor	0.64	330.55	330.70	330.70	330.77	0.005576	2.17	0.29	2.00	1.00
i_59Sa	49		Culvert									
i_59Sa	9.1	Steady Peak Stor	0.64	329.27	329.63	329.63	329.72	0.059744	2.40	0.27	1.47	0.99
i_59Sa	4.3	Steady Peak Stor	0.64	329.00	329.36	329.32	329.41	0.030271	1.77	0.36	2.00	0.73
i_59Sa	0.00	Steady Peak Stor	0.64	328.92	329.17	329.17	329.23	0.060142	2.00	0.32	2.55	0.99
i_59Sa	-65		Culvert									
i_59Sa	-130	Steady Peak Stor	0.64	313.00	313.18		313.19	0.006681	0.82	0.78	4.55	0.35
i_59Sa	-132	Steady Peak Stor	0.64	313.00	313.09	313.09	313.14	0.078006	1.77	0.36	4.26	1.07
i_59Sa	-150	Steady Peak Stor	0.64	308.00	308.03	308.10	308.55	3.864839	5.82	0.11	4.08	6.25
i_59Sa	-152	Steady Peak Stor	0.64	308.00	308.20	308.11	308.21	0.006900	0.83	0.77	4.53	0.36
i_59Sa	-154	Steady Peak Stor	0.64	308.00	308.11	308.11	308.16	0.098240	1.76	0.36	3.80	1.00
i_59Sa	-302	Steady Peak Stor	0.64	251.00	251.59	251.42	251.62	0.010996	1.33	0.48	1.63	0.43
i_59Sa	-304	Steady Peak Stor	0.64	251.00	251.42	251.42	251.53	0.065191	2.60	0.25	1.16	0.99
i_59Sa	-326.5		Culvert									
i_59Sa	-349	Steady Peak Stor	0.64	249.00	249.06	249.06	249.09	0.075315	1.40	0.46	7.57	1.00
i_59Sa	-369	Steady Peak Stor	0.64	248.00	248.14	248.07	248.15	0.010003	0.82	0.78	6.25	0.41

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: IMP 0.85cfs River: Above Lucini Reach: i_59Sa Profile: Steady Peak Stor

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
i_59Sa	175.3	Steady Peak Stor	0.85	334.50	334.76	334.68	334.77	0.010967	0.88	0.97	7.54	0.43
i_59Sa	157.5	Steady Peak Stor	0.85	334.00	334.30	334.30	334.37	0.059039	2.21	0.39	2.60	1.01
i_59Sa	154.8	Steady Peak Stor	0.85	331.80	331.89	332.08	333.29	0.215416	9.51	0.09	1.00	5.60
i_59Sa	120		Culvert									
i_59Sa	94.5	Steady Peak Stor	0.85	330.60	330.78	330.78	330.87	0.004860	2.31	0.37	2.00	0.95
i_59Sa	91.8	Steady Peak Stor	0.85	330.55	330.79	330.73	330.84	0.002135	1.77	0.48	2.00	0.64
i_59Sa	89.1	Steady Peak Stor	0.85	330.55	330.73	330.73	330.82	0.005435	2.39	0.36	2.00	1.00
i_59Sa	49		Culvert									
i_59Sa	9.1	Steady Peak Stor	0.85	329.27	329.68	329.68	329.78	0.057611	2.55	0.33	1.64	1.00
i_59Sa	4.3	Steady Peak Stor	0.85	329.00	329.33	329.36	329.46	0.093919	2.90	0.29	1.80	1.26
i_59Sa	0.00	Steady Peak Stor	0.85	328.92	329.21	329.21	329.27	0.044824	1.92	0.44	3.00	0.88
i_59Sa	-65		Culvert									
i_59Sa	-130	Steady Peak Stor	0.85	313.00	313.21		313.22	0.007623	0.95	0.90	4.62	0.38
i_59Sa	-132	Steady Peak Stor	0.85	313.00	313.11	313.11	313.16	0.075371	1.95	0.44	4.31	1.08
i_59Sa	-150	Steady Peak Stor	0.85	308.00	308.03	308.11	308.67	3.636185	6.39	0.13	4.10	6.25
i_59Sa	-152	Steady Peak Stor	0.85	308.00	308.05	308.13	308.51	1.668853	5.47	0.16	3.37	4.49
i_59Sa	-154	Steady Peak Stor	0.85	308.00	308.13	308.13	308.18	0.092597	1.91	0.45	3.96	1.00
i_59Sa	-302	Steady Peak Stor	0.85	251.00	251.66	251.47	251.69	0.010986	1.43	0.59	1.81	0.44
i_59Sa	-304	Steady Peak Stor	0.85	251.00	251.47	251.47	251.59	0.065314	2.79	0.30	1.29	1.01
i_59Sa	-326.5		Culvert									
i_59Sa	-349	Steady Peak Stor	0.85	249.00	249.07	249.07	249.11	0.084703	1.61	0.53	7.65	1.08
i_59Sa	-369	Steady Peak Stor	0.85	248.00	248.16	248.10	248.18	0.010013	0.91	0.94	6.47	0.42

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: IMP 1.95cfs River: Above Lucini Reach: i_59Sa Profile: Steady Peak Stor

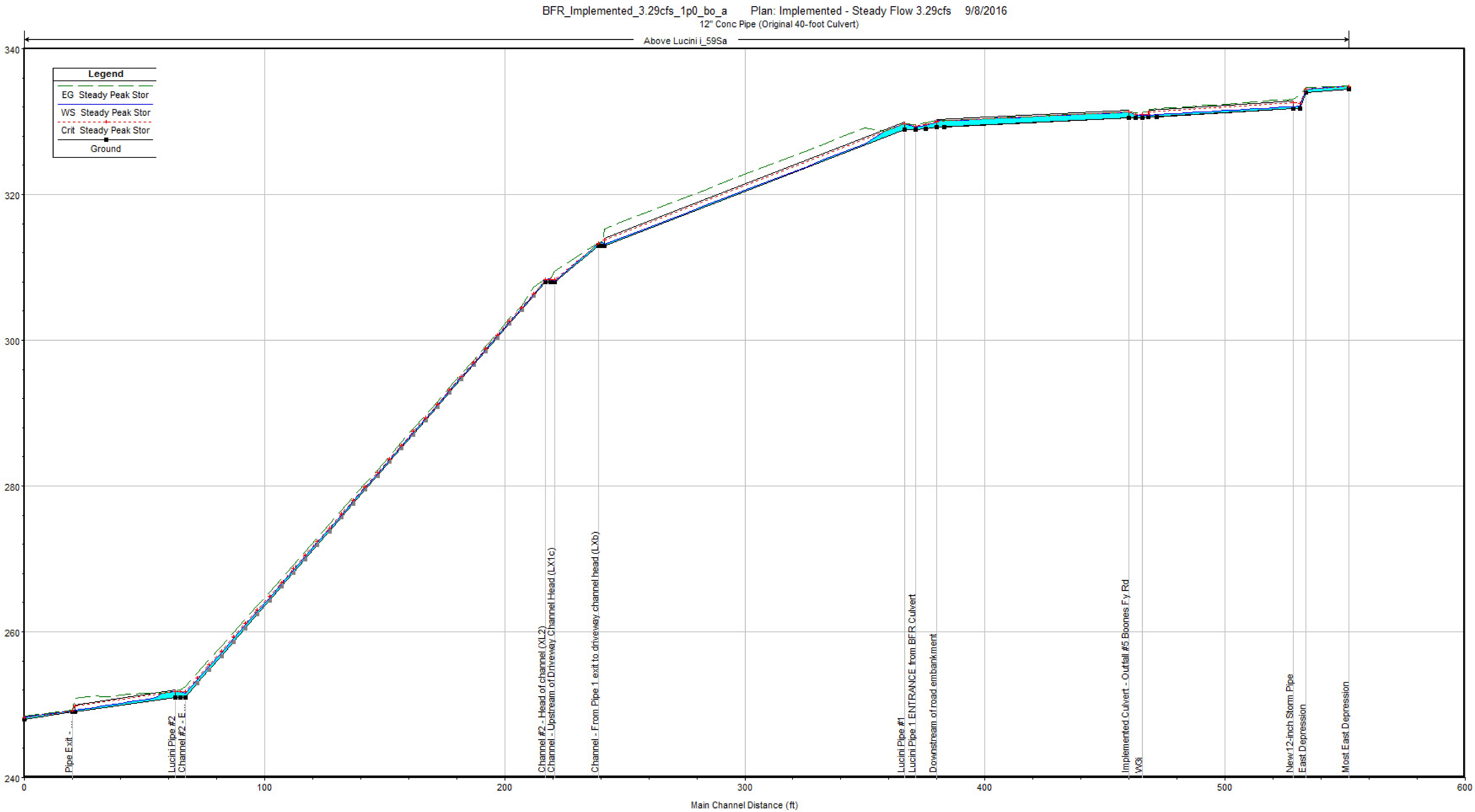
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
i_59Sa	175.3	Steady Peak Stor	1.95	334.50	334.85	334.75	334.87	0.010335	1.06	1.84	10.41	0.44
i_59Sa	157.5	Steady Peak Stor	1.95	334.00	334.41	334.41	334.52	0.051301	2.58	0.76	3.65	1.00
i_59Sa	154.8	Steady Peak Stor	1.95	331.80	332.00	332.29	333.49	0.098788	9.80	0.20	1.00	3.87
i_59Sa	120		Culvert									
i_59Sa	94.5	Steady Peak Stor	1.95	330.60	330.94	330.91	331.07	0.003944	2.87	0.68	2.00	0.87
i_59Sa	91.8	Steady Peak Stor	1.95	330.55	330.96	330.86	331.05	0.002295	2.40	0.81	2.00	0.66
i_59Sa	89.1	Steady Peak Stor	1.95	330.55	330.86	330.86	331.01	0.005240	3.16	0.62	2.00	1.00
i_59Sa	49		Culvert									
i_59Sa	9.1	Steady Peak Stor	1.95	329.27	329.84	329.84	329.98	0.052108	3.02	0.65	2.29	1.00
i_59Sa	4.3	Steady Peak Stor	1.95	329.00	329.44	329.50	329.65	0.105045	3.72	0.52	2.40	1.40
i_59Sa	0.00	Steady Peak Stor	1.95	328.92	329.31	329.31	329.41	0.053963	2.54	0.77	3.96	1.01
i_59Sa	-65		Culvert									
i_59Sa	-130	Steady Peak Stor	1.95	313.00	313.32		313.35	0.009015	1.34	1.45	4.97	0.44
i_59Sa	-132	Steady Peak Stor	1.95	313.00	313.18	313.19	313.28	0.061572	2.49	0.78	4.55	1.06
i_59Sa	-150	Steady Peak Stor	1.95	308.00	308.06	308.19	309.21	3.355479	8.62	0.23	4.17	6.52
i_59Sa	-152	Steady Peak Stor	1.95	308.00	308.36	308.21	308.38	0.008566	1.27	1.54	5.66	0.43
i_59Sa	-154	Steady Peak Stor	1.95	308.00	308.21	308.21	308.30	0.080059	2.39	0.82	4.61	1.00
i_59Sa	-302	Steady Peak Stor	1.95	251.00	251.46	251.66	252.14	0.375315	6.62	0.29	1.27	2.42
i_59Sa	-304	Steady Peak Stor	1.95	251.00	251.66	251.66	251.82	0.058525	3.30	0.59	1.80	1.01
i_59Sa	-326.5		Culvert									
i_59Sa	-349	Steady Peak Stor	1.95	249.00	249.13	249.13	249.19	0.064594	2.02	0.97	8.15	1.03
i_59Sa	-369	Steady Peak Stor	1.95	248.00	248.26	248.16	248.29	0.010003	1.20	1.63	7.37	0.45

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: IMP 3.29cfs River: Above Lucini Reach: i_59Sa Profile: Steady Peak Stor

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
i_59Sa	175.3	Steady Peak Stor	3.29	334.50	334.94	334.82	334.96	0.009048	1.15	2.87	12.99	0.43
i_59Sa	157.5	Steady Peak Stor	3.29	334.00	334.51	334.51	334.64	0.049598	2.90	1.13	4.47	1.01
i_59Sa	154.8	Steady Peak Stor	3.29	331.80	332.13	332.49	333.66	0.064421	9.91	0.33	1.00	3.03
i_59Sa	120		Culvert									
i_59Sa	94.5	Steady Peak Stor	3.29	330.60	330.90	331.04	331.37	0.016296	5.49	0.60	2.00	1.77
i_59Sa	91.8	Steady Peak Stor	3.29	330.55	330.85	330.99	331.32	0.016296	5.49	0.60	2.00	1.77
i_59Sa	89.1	Steady Peak Stor	3.29	330.55	330.90	330.99	331.24	0.010077	4.68	0.70	2.00	1.39
i_59Sa	49		Culvert									
i_59Sa	9.1	Steady Peak Stor	3.29	329.27	329.96	329.96	330.14	0.050085	3.39	0.97	2.80	1.01
i_59Sa	4.3	Steady Peak Stor	3.29	329.00	329.53	329.61	329.81	0.102500	4.20	0.78	2.93	1.43
i_59Sa	0.00	Steady Peak Stor	3.29	328.92	329.30	329.40	329.60	0.164469	4.39	0.75	3.91	1.77
i_59Sa	-65		Culvert									
i_59Sa	-130	Steady Peak Stor	3.29	313.00	313.43		313.47	0.009499	1.63	2.02	5.30	0.47
i_59Sa	-132	Steady Peak Stor	3.29	313.00	313.26	313.27	313.39	0.057058	2.94	1.12	4.77	1.07
i_59Sa	-150	Steady Peak Stor	3.29	308.00	308.08	308.27	309.51	2.468790	9.60	0.34	4.25	5.96
i_59Sa	-152	Steady Peak Stor	3.29	308.00	308.46	308.29	308.50	0.009105	1.51	2.18	6.46	0.46
i_59Sa	-154	Steady Peak Stor	3.29	308.00	308.29	308.29	308.41	0.073053	2.73	1.21	5.21	1.00
i_59Sa	-302	Steady Peak Stor	3.29	251.00	251.56	251.81	252.44	0.373059	7.52	0.44	1.55	2.50
i_59Sa	-304	Steady Peak Stor	3.29	251.00	251.81	251.81	252.02	0.054487	3.66	0.90	2.22	1.01
i_59Sa	-326.5		Culvert									
i_59Sa	-349	Steady Peak Stor	3.29	249.00	249.18	249.18	249.27	0.056065	2.33	1.41	8.63	1.01
i_59Sa	-369	Steady Peak Stor	3.29	248.00	248.35	248.22	248.38	0.010012	1.42	2.32	8.17	0.47



BFR_Implemented_3.29cfs_1p0_bo_a Plan: Implemented - Steady Flow 3.29cfs 9/8/2016
12" Conc Pipe (Original 40-foot Culvert)
Above Lucini i_59Sa
Legend
EG Steady Peak Stor
WS Steady Peak Stor
Crit Steady Peak Stor
Ground
Pipe Exit - ...
Lucini Pipe #2
Channel #2 - E...
Channel #2 - Head of channel (XL2)
Channel - Upstream of Driveway Channel Head (LX1c)
Channel - From Pipe 1 exit to driveway channel head (LXb)
Lucini Pipe #1
Lucini Pipe 1 ENTRANCE from BFR Culvert
Downstream of road embankment
Implemented Culvert - Outfall #5 Boones Fy Rd
W3i
New 12-inch Storm Pipe
East Depression
Most East Depression
Main Channel Distance (ft)

ATTACHMENT #4

MAPS WITHIN PROPOSED UPDATE TO THE CITY'S MASTER PLAN

PROPOSED MAPS:
-CONTAIN DATED INFORMATION
-OMISSION OF RELAVENT AND NESSARY INFORMATION REQUIRED FOR LAND USE PLANNING

An example of questionable information provided within many maps within the proposed Stormwater Management Plan for the City, is **Figure 2-2 Project Area Overview**.

T**he Legend within Figure 2-2 provides keys as to the location of**

- **Open Space-Parks/Greenways/Natural Areas/Private***
- **Open Space- WPA/Setbacks/NRPO/Wetlands**

However, there is no indication of the wetlands, and multiple Natural Resources known to exist within the Basalt Creek Area and within the Basalt Creek Canyon.

Many of these types of Natural Resources may be negatively affected by stormwater drainage, and an accurate assessment as to the quantity, quality and location of Natural Resources which are to be conserved and protected should be assessed evaluated and memorialized within a Stormwater Management Plan and integrated into the City's Governing Documents for to provide and assure consistency within the City's various Land Use Plans.

Another factor not denoted within the maps within proposed Stormwater Management Plan, is the identification of the "Natural Area" within the Basalt Creek Canyon.

This area which contains wetlands and various Natural Resources requiring conservation and protection was identified within the Basalt Creek Concept Plan in which both Cities agreed to have "joint management" of the "Natural Area". It would seem reasonable this information which might impact Land Use Planning within the Basalt Creek Area and is downstream from the Basalt Creek lands already annexed into the City, would be identified on the Figure 2-2 map, and include additional information within the narrative of the proposed Stormwater Management Plan as a potential constraint or limitation in the planning of Stormwater Management in the area or upstream from the "Natural Area".

This map also includes the notation of "Brown and Caldwell City of Tualatin Stormwater Master Plan Date: April 2019 Project 149233 in the lower left corner of the map. An assumption would be that the information provided within this map would be current and accurate as of April 2019- the date indicated on the lower left corner of the map. It is unknown how current the information contained within this map may be but lacking the inclusion of information Basalt Creek Area lands already within the City's boundaries, makes one question when the data for this map was last collected.

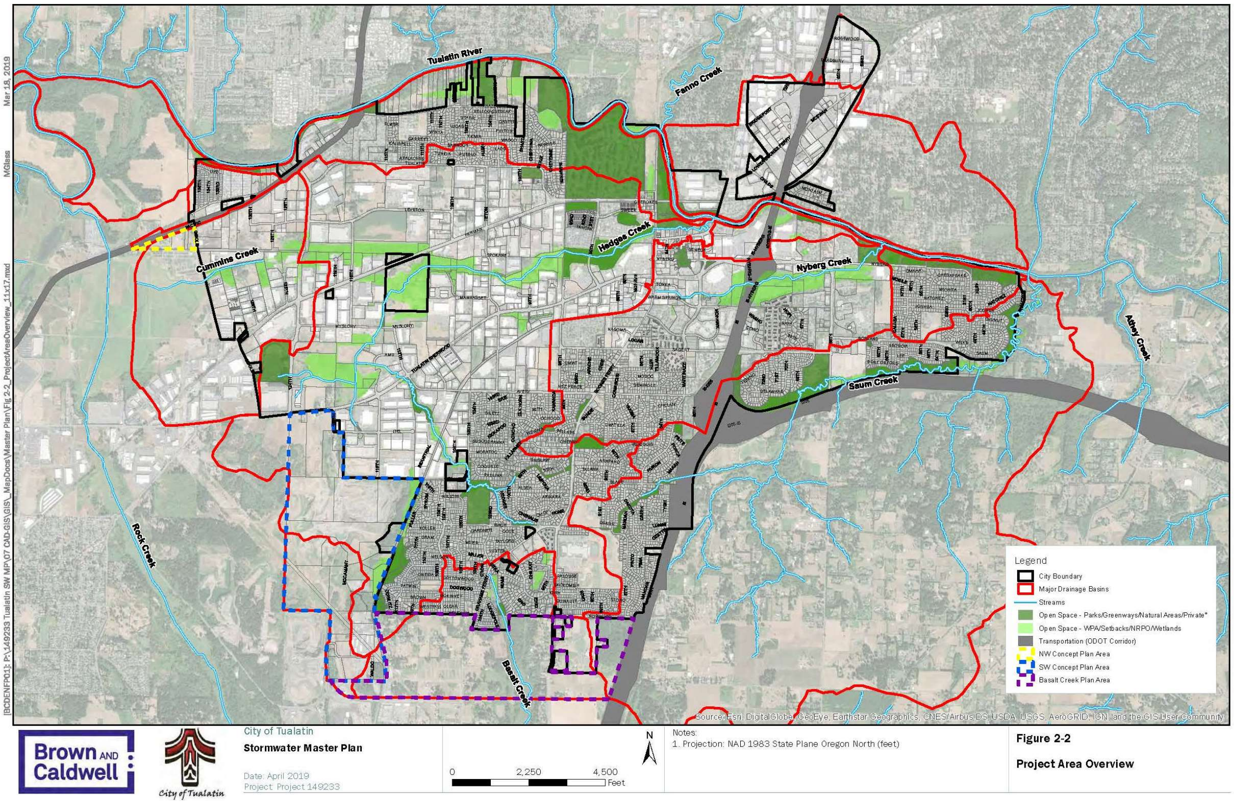
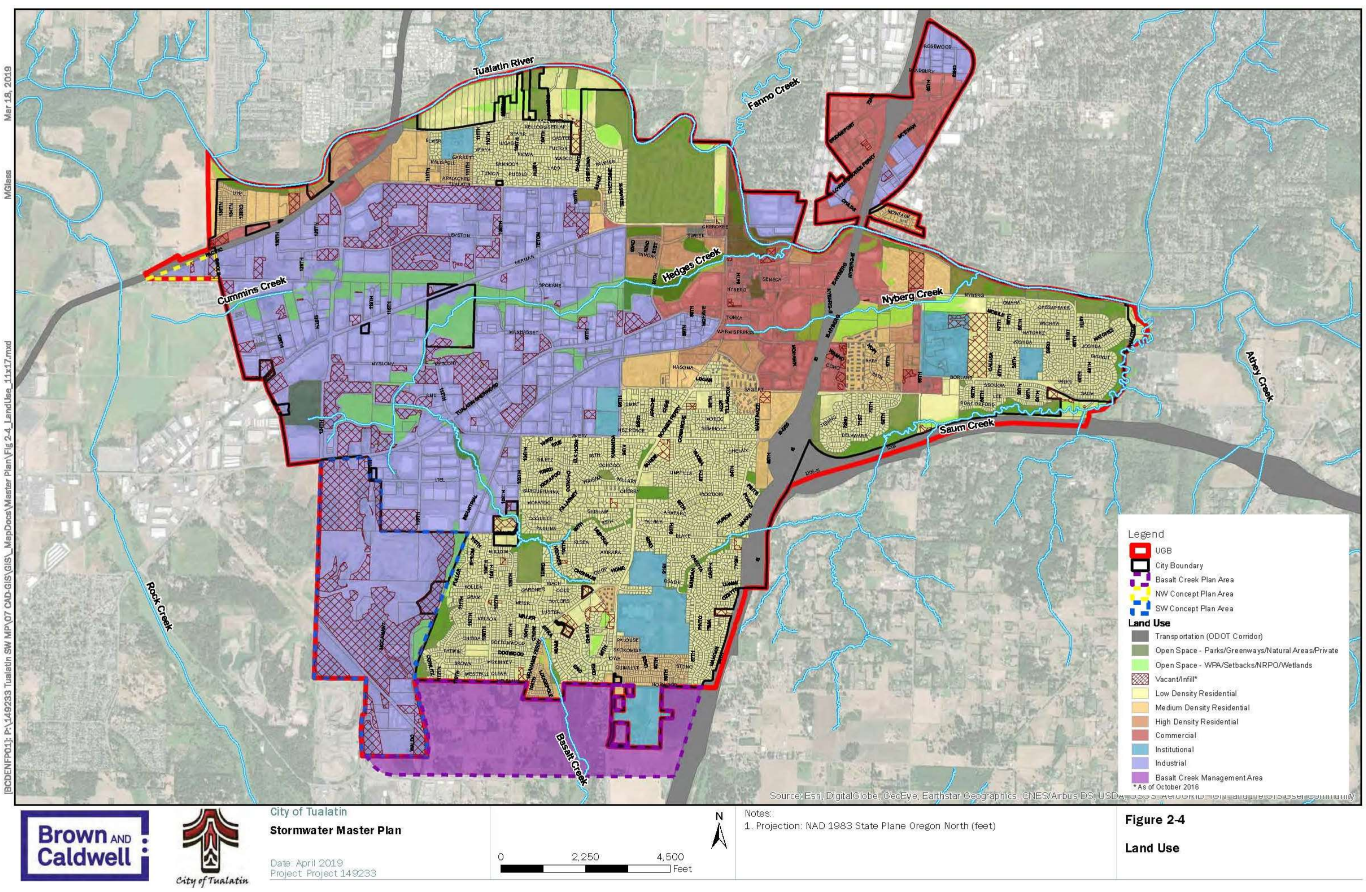

Tualatin River
Fanno Creek
Hedges Creek
Cummins Creek
Nyberg Creek
Saum Creek
Athey Creek
Rock Creek
Basalt Creek
Legend
City Boundary
Major Drainage Basins
Streams
Open Space - Parks/Greenways/Natural Areas/Private*
Open Space - WPA/Setbacks/NRPO/Wetlands
Transportation (ODOT Corridor)
NW Concept Plan Area
SW Concept Plan Area
Basalt Creek Plan Area
Brown AND Caldwell
City of Tualatin
City of Tualatin
Stormwater Master Plan
Date: April 2019
Project: Project 149233
0
2,250
4,500
Feet
N
Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)
Figure 2-2
Project Area Overview

Figure 2-4 "Land Use" Map Not Consistent with City's Current Land Use Zoning
also provides the notation of "Brown and Caldwell City of Tualatin Stormwater Master Plan Date: April 2019 Project 149233 in the lower left corner of the map.

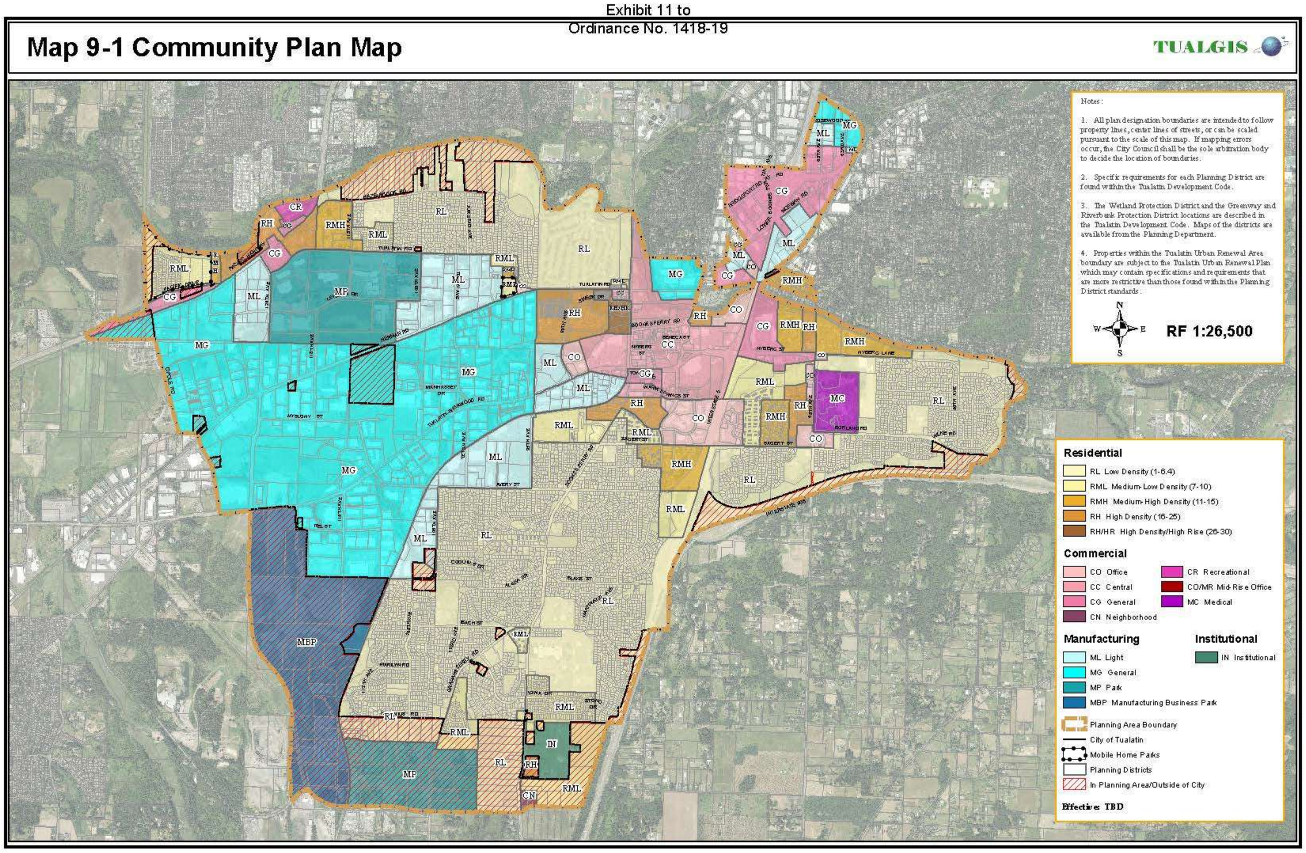
Yet, an asterisk notation within the Legend box states, "* As of October 2016".
Major changes have occurred as to Land Use within the City of Tualatin in the four years since this map was apparently generated.

The information provided as to the Land Use zoning or designations do not accurately reflect the Land Use Planning Actions of the Basalt Creek Concept Plan adopted in 2018, nor the City of Tualatin Basalt Creek Comprehensive Plan. Land Use Zoning within the Basalt Creek Area does not provide accurate information of current Land Use Zoning and Planning within the Basalt Creek Area and may hinder the planning for Stormwater Management in the assessment of current and future needs based upon type of land use. Approximately 60 acres within the Basalt Creek Area have already been annexed into the City of Tualatin, and into the responsibilities and regulations of the City for Land Use planning- including Stormwater Management.



The proposed Stormwater Master Plan Update is not consistent with the Land Use Plan adopted by the City in 2019 in Ordinance 1418-19, and consequently would not be compliant with Statewide Planning Goal #2

Exhibit 11 to
Ordinance No. 1418-19

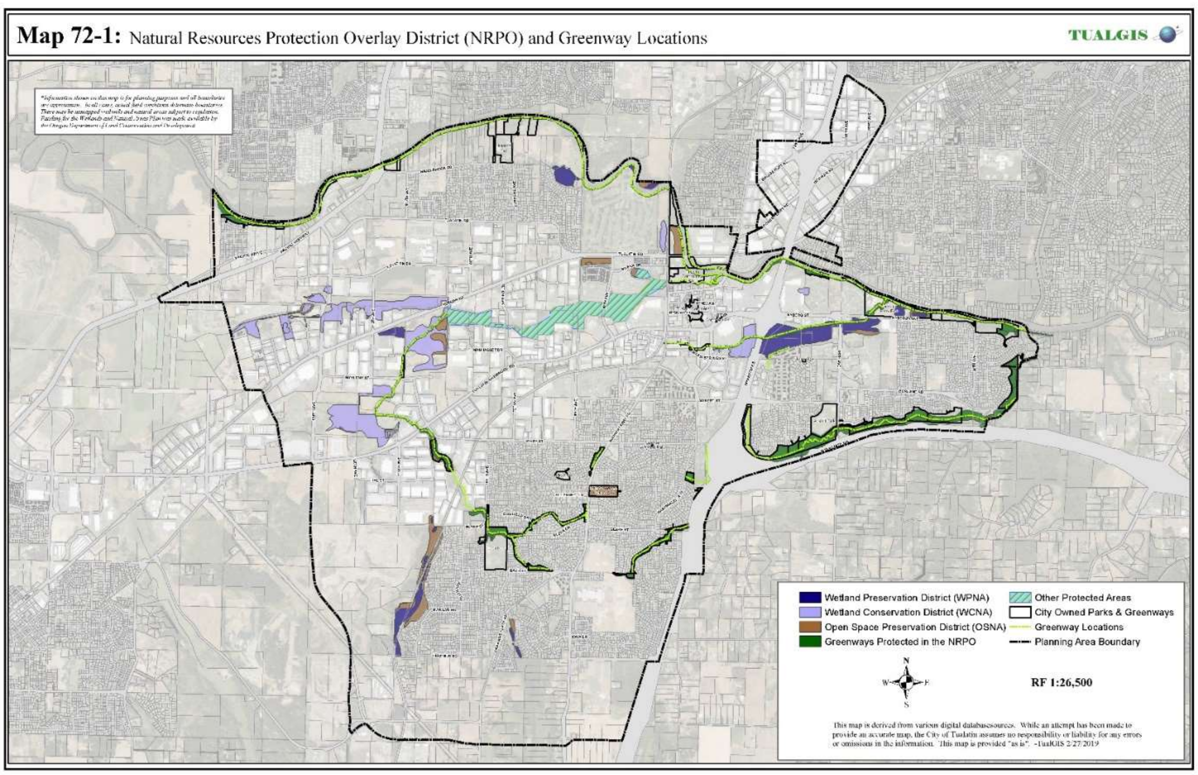


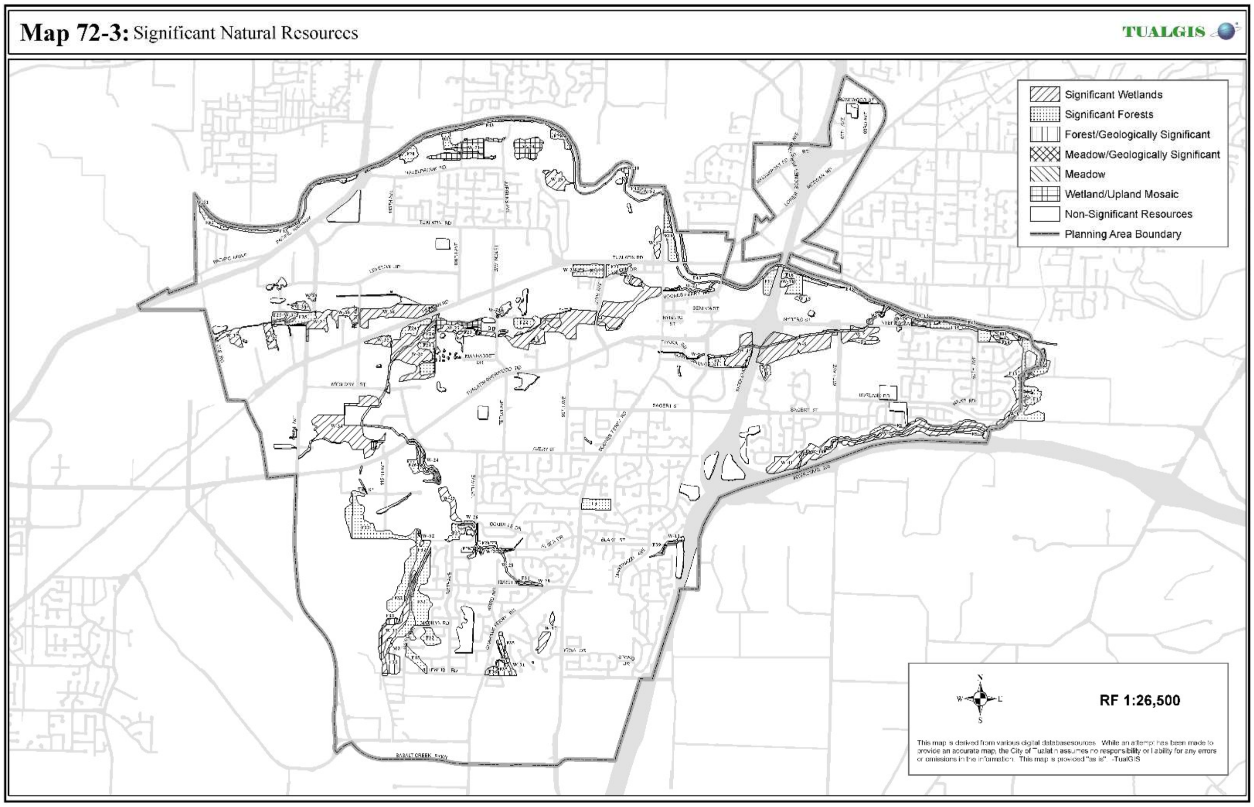
72-1 Natural Resources Protection Overlay district (NRPO) and Greenway Locations
72-3 Significant Natural Resources
There is an absence of necessary information provided for the Basalt Creek Area for Natural Resources

Lacking necessary evaluations as to the level, location and quality of Natural Resources within the Basalt Creek Area within the proposed Stormwater Management Master Plan Update, it would be difficult for the City of Tualatin to utilize the maps adopted into the City's Governing Documents (as part of the adoption of the Basalt Creek Comprehensive (Ord. 1427-19 , § 47, 11-25-19)), as supportive or back up documents to the proposed Update, as these maps obtained from the City's website do not identify or provide substantive information as to the multiple Natural Resources which are known to exist within the Basalt Creek Area.

City of Tualatin Maps downloaded from the City's municipal Code website
https://library.municode.com/or/tualatin/codes/development_code?nodeId=THDECOTUOR_APXAMA

also lack essential information necessary for the development of a Land Use Plan, or effective implementation of a Land Use Action within the Basalt Creek Area and are not suitable support documents for the proposed Update to the City's proposed Stormwater Management Master Plan Update.





There are signficant inconsistancies in the level of acknolwedgement and identification of various Natural Resourcse which are required to be evaluated for potential impact within all Land Use Plans, and Planning Actions. The omission of pertenant information regarding the existance of multipe Natural Resources within the northern portion of the Basalt Creek Area as presented within the City's Governing Documents, and within the City's proposed Stormwater Master Plan update are notable.

However, the City included the Basalt Creek Concept Plan document adopted by the City in 2018, and utilized as a supporting document to the Basalt Creek Comprehensive Plan in 2019 did provide needed information as to Land Use evaluative factors such as the Natural Resources and contraints which exist within the Basalt Creek Area.

Examples of pertenent documentation from the Basalt Creek Concept Plan as to the quanity and quality of these Natural Resources is provided including a summary of a rational for inclusion of this information into the Basalt Creek Land Use Concept Plan.

Metro Title 13: Nature in Neighborhoods

Title 13 requires local jurisdictions to protect and encourage restoration of a continuous ecologically viable streamside corridor system integrated with upland wildlife habitat and the urban landscape. Metro's regional habitat inventory in 2001 identified the location and health of fish and wildlife habitat based on waterside, riparian and upland habitat criteria. These areas were named Habitat Conservation Areas.

Table 7 Title 13 HCA Categories with Acreage

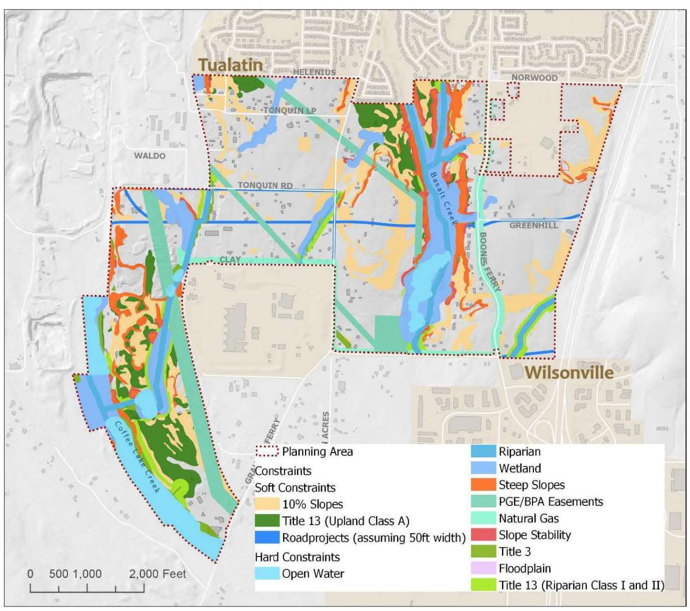
HCA Categories	Acres	Description
Riparian Wildlife Habitat Class I	130	Area supports 3 or more riparian functions
Riparian Wildlife Habitat Class II	31	Area supports 1 or 2 primary riparian functions
Riparian Wildlife Habitat Class III	7	Area supports only secondary riparian functions outside of wildlife areas
Upland Wildlife Habitat Class A	103	Areas with secondary riparian value that have high value for wildlife habitat
Upland Wildlife Habitat Class B	72	Area with secondary riparian value that have medium value for wildlife habitat
Upland Wildlife Habitat Class C	37	Areas with secondary riparian value that have low value for wildlife habitat
Designated Aquatic Impact	52	Area within 150 ft. of streams, river, lakes, or wetlands

Exhibit 2 to
Ordinance No. 1418-19

Environmental constraints are summarized below and unless otherwise noted were fully excluded from the developable land input in the scenario testing for the Basalt Creek Concept Plan:

- Open Water
- Streams
- Wetlands
- Floodplains (50% reduction of developable area)
- Title 3 Water Quality and Flood Management protections
- Title 13 Nature in Neighborhoods (20% reduction of developable area in areas designated Riparian Habitat Classes I and II)
- Steep Slopes (25% slopes and greater)

Figure 13 Natural Resources Map



It is unclear as to the rational for the omission of pertenent information required to be an evaluated compent in the development of all Land Use Plans and implmentation of Planning Actions have not been included within the proposed Stormwater Master Plan Update, nor in the City's Governing Documents as provided via the City's

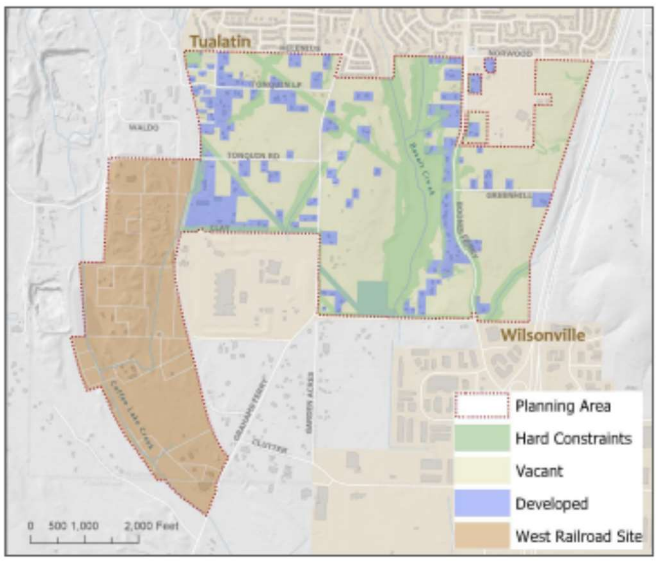
Exhibit 2 to
Ordinance No. 1418-19

The goal is to classify every parcel within the Planning Area into one of the categories described below:

Table 2 Land Supply within the Basalt Creek Planning Area by Type and with Acreage.

Land Supply by Type and Acreage		
Land Type	**Acres**	**Description**
Vacant Land	331	Unconstrained land that is ready to build with no major structures located on the site
Developed Land	125	Land already built upon which includes acreage covered by roadways
Constrained Land	153	Land that cannot be built upon due to environmental or other hard constraints
West Railroad Area	238	Excluded from development plan due to large amount of constraints and limited access
Total Land Supply	**847**	

Figure 6 Land Supply by Type.



21

From: Steve Koper
Sent: Tuesday, January 12, 2021 1:26 PM
To: Tabitha Boschetti
Subject: FW: FW: Tualatin Planning Commission

Follow Up Flag: Follow up
Flag Status: Completed

From: G Lucini <grluci@gmail.com>
Sent: Sunday, January 10, 2021 1:28 PM
To: Steve Koper <skoper@tualatin.gov>; Hayden Ausland <hausland@tualatin.gov>; Kim McMillan <kmcmillan@tualatin.gov>
Cc: Council <council@tualatin.gov>
Subject: Re: FW: Tualatin Planning Commission

Please include this correspondence as part of the Public Record for the City of Tualatin's proposed Land Use Action to Update the City's Stormwater Master Plan Update.

As a method to contact and directly submit Citizen Input to the State's mandated Committee for Citizen Involvement (CCI) or City's State authorized alternate, nor is a direct method to contact the City of Tualatin Planning Commission, provided on the City's designated Public website, would the City provide us assurance a copy of this communication is provided in a timely manner to these Committees/Commissions which make recommendations to the Governing Bodies for making the City's Land Use decisions.

Thank you for the invitation to the City of Tualatin Planning Commission Meeting scheduled for 1-21-2021, sent on 1-6-2021.

The email did not specify the reason for the invitation to the virtual Planning Commission Meeting and did not include an agenda of topics to be discussed during the Public Meeting of the TPC on 1-21-2021 (a major requirement of Notice for Public Meetings).

Nor has the agenda for this meeting been posted to the City's website Calendars for Public Meetings.

It is unclear from the invitation, and unclear from a somewhat comprehensive review of the City's website- as to which role and function Tualatin Planning Commission will be conducting business on 1-21-2021.

Consequently, my husband and I are somewhat confused as to the purpose of the invitation; the subject/s to be discussed; and specifics as to how the virtual meeting will be conducted.

1. **Would you provide information as to any administrative procedures- including any time limits for Citizen verbal comments/discussions, or other limitations or constraints -which might apply to us during the 1-21-2021 meeting.**

2. Understanding the need for a virtual meeting, how does a member of the Public provide the members of the TPC access to documents which may provide clarification or support of Citizen Concerns to be discussed during the TPC virtual meeting?

3. Will the City provide us a copy of the agenda for the 1-21-2021 TPC meeting?

A. Would the City clarify if the purpose of the TPC meeting on 1-21-2021 will be to conduct the business and responsibilities of a Planning Commission, or to implement and fulfill the differing role and functions of a State mandated Committee for Citizen Involvement?

In reviewing the November and December 2020 agendas for the Tualatin Planning Commission (TPC) as posted as part of General Notice on the City's Calendar of Public Meetings website for the City, it was noted the TPC agendas did not list an agenda item for a Citizen Comment period and did not list agenda items relating to the specifics of implementation and review for mandated components of the Oregon Statewide Planning Goal #1 for Citizen Involvement.

B. Is the City's proposed Update to the Stormwater Master Plan an agenda item for the 1-21-2021 meeting?

My husband and I previously submitted Citizen Comments to the City on 12-15-2020-during the City's designated Citizen Comment period for the proposed draft of the Update to the City's Stormwater Master Plan.

As of yet, we have not received a response from the City or elected or appointed officials on the substantial comments we provided to the City. Our comments were also supported by multiple relevant documents.

Included within those documents, was a review and comments of draft as posted to the City's website on the 12-1-2020, and a review of the City's supporting technical documents, by an extremely professionally qualified consultant. In addition, we provided copies of the stormwater conveyance system within the NE Basalt Creek Area; hydraulic modeling within the NE Basalt Creek Area (including lands recently annexed to the City and portions within the future jurisdiction of the City) and conclusions from the previously conducted studies by our consultant. This type of necessary relevant information relating to Stormwater Management within the NE Basalt Creek area was missing from the City's proposed Stormwater Management Master Plan.

Due to the wealth of information we already provided to the City, and the extent of our concerns regarding the proposed Stormwater Master Plan draft in its current form, coupled with the lack of feedback we have receive from the City-it is curious to us as to why the City might have this proposed Land Use Action brought before the City's Planning Commission at this time.

As we would like to be prepared for the 1-21-2021 meeting, should the Stormwater Master Plan Update be an agenda item up for discussion, we would like to understand the purpose and intent for bringing this proposed Land Use Plan before the TPC.

- **Will the TPC be meeting in the role of the Planning Commission to review the proposed draft of the Update to the City's Stormwater Master Plan as part of the City's Land Use process and possibly be making recommendations on forwarding the proposed draft to the City Council for adoption?**

Or

- **Will the TPC be meeting as the City's designated Committee for Citizen Involvement-**

  - **to assure effective two-way communication with citizens by providing a mechanism for effective communication between citizens and elected and appointed officials**

  - **providing further information or providing us a response and rational to the comments and concerns we submitted to the City on 12-15-2020,**

  - **to provide a method for Citizen Involvement within the Preparation of Plans and Implementation Measures, Plan Content, Plan Adoption, Minor Changes and Major Revisions in the Plan, and Implementation Measures?**

4. We understand the City has designated the TPC as the City's Committee for Citizen Involvement (CCI) for the City's Land Use Planning process.

The State's Goal #1 for Citizen Involvement requires *"If the planning commission is to be used in lieu of an independent CCI, its members shall be selected by an open, well-publicized public process"*

As the proposed Update to the City's Stormwater Master Plan will potentially affect hundreds of acres of lands within the Basalt Creek Area- which were not previously included within the previous Stormwater Master Plan---has the City Council selected and provided a CCI member *"broadly representative of geographic areas and interests related to land use"* within the Basalt Creek Area as per the State's requirements for an open well- publicized public process?

City of Tualatin's Implementation of Statewide Land Use Planning Goal #1 for Citizen Involvement Mandated Committee for Citizen Involvement (CCI) verses Mandated Publicized Citizen Involvement Program

We cannot locate a publicized program on the City's website which *"clearly defines the procedures"* by which the general public (regardless of location of residence) is provided continuous involvement in the on-going land-use planning process- including *"Preparation of Plans and Implementation Measures, Plan Content, Plan Adoption, Minor Changes and Major Revisions in the Plan, and Implementation Measures."*

My husband and I want to understand the various aspects (and any subsequent proposed changes) of the proposed Land Use Plan Update to the City's Stormwater Master Plan. And we wish to effectively participate in all phases of this Proposed Land Use Action as part of Citizen Engagement and Involvement for this proposed Land Use Action (as per Oregon Statewide Land Use Planning Goals #1 OAR 660-015-0000(1) and #2 OAR 660-015-0000(2)).

As the Oregon Statewide Land Use Planning Goal #1 for Citizen Involvement states *"the Citizen Involvement Program shall be appropriate to the scale of the planning effort"*, it would be assumed a proposed Land Use Master Plan Update which impacts the entirety of the lands within the current City Limits, and additional lands within the northern portion of the Basalt Creek Area under the future jurisdiction the City, and has taken years to create-would require the scale of the Citizen Involvement Program for this proposed Land Use Plan Update to be fairly large and extensive.

Specifically, to the TPC meeting on 1-21-2021, since we have not been able to find clear information as to the Goal #1 requirement for a Citizen Involvement Program to be use for this proposed Master Plan Update, we submit the following information and questions to the City.

Should the proposed draft of the Stormwater Master Plan be on the TPC 1-21-21 agenda, we would like to be able to have access to timely accurate information, and access to any changes or the most recent draft version on the proposed Land Use Master Plan Update<u>- to allow for a reasonable timeframe to review and understand the proposed Land Use Plan ---prior to the 1-21-2021 TPC Public Meeting.</u>

5. In the future, if any changes have been made – or will be made -to the proposed draft and/or the related technical documents since the City posted information on the City's website for the Citizen Comment Period ending 12-15-2020---

A. **Will the City provide the Public easily identifiable internet access–to any changes to the proposed (as posted to the City's website on 12-1-2020, and/or any future iterations), which contain <u>major</u> or <u>minor</u> changes to the proposed Stormwater Master Plan Update?**

B. To assure that technical information is available to the Public in an understandable form- If the City makes any subsequent changes to the 12-1-2020 version of the proposed draft (referenced in #5A) **– will the City identify/ indicate any future changes to the proposed Land Use Plan (perhaps by strikeouts, highlights, or by other means) within all future proposed versions or drafts of the proposed Land Use Plan?**

C. **Will the City provide appropriate General Notice, and appropriate Actual Notice to Interested Persons, of any Public Meetings on any proposed major or minor changes to the 12-1-2020 draft (as referenced in #5 A) of the City's Update to the Stormwater Master Plan- or future iterations?**

As a reminder, my husband and I have previously identified ourselves to the City as Interested Persons who have submitted written request to be provided Actual Notice of any/all future Public Meetings regarding the proposed Update to the City of Tualatin Stormwater Master Plan.

D. **In the future, will the City make available to the Public via internet access any proposed changes to, or to the most current iterations of the 12-1-2020 draft of the Master Plan Update (as referenced in #5 A)---*<u>within a reasonable timeframe to allow for Public review and understanding, prior</u>* <u>to any/all Public Meetings which may be held to forward the proposed Update within the City's Land Use Planning process</u>?**

It should be noted, the answers to some of these questions will impact the Public's ability to address the challenges created by the COVID-19 pandemic.

Again, thank you for your invitation to the Tualatin Planning Commission meeting on 1-21-2021.

We look forward to a timely reply to this email, and a response to our comments submitted to the City on 12-15-2020 regarding the proposed Update to the City's Stormwater Master Plan.

Regards,

John and Grace Lucini

On Wed, Jan 6, 2021 at 1:57 PM Steve Koper <skoper@tualatin.gov> wrote:

> Good afternoon Grace,
>
> I wanted to notify you of the upcoming Planning Commission meeting, so please consider this a formal invitation to the Planning Commission meeting on January 21st from 6:30 to 9:30PM.
>
> Regards,
>
> Hayden Ausland, CPSWQ
> Engineering Associate - Water Quality
> City of Tualatin
> hausland@tualatin.gov
> 503-691-3037
>
> -----Original Appointment-----
> From: Steve Koper <skoper@tualatin.gov>
> Sent: Wednesday, January 6, 2021 11:27 AM
> To: Steve Koper; Kim McMillan; Hayden Ausland
> Subject: Tualatin Planning Commission
> When: Thursday, January 21, 2021 6:30 PM-9:30 PM (UTC-08:00) Pacific Time (US & Canada).
> Where:
> https://us02web.zoom.us/j/83673581282?pwd=K3MyM3AzL1NIdmRIL2xJYWtJV2tQdz09
>
> Community Development is inviting you to a scheduled Zoom meeting.
>
> Join Zoom Meeting
> https://us02web.zoom.us/j/83673581282?pwd=K3MyM3AzL1NIdmRIL2xJYWtJV2tQdz09
>
> Meeting ID: 836 7358 1282
> Passcode: 542101
> One tap mobile
> +13462487799,,83673581282#,,,,,,0#,,542101# US (Houston)
> +16699009128,,83673581282#,,,,,,0#,,542101# US (San Jose)

Dial by your location
+1 346 248 7799 US (Houston)
+1 669 900 9128 US (San Jose)
+1 253 215 8782 US (Tacoma)
+1 312 626 6799 US (Chicago)
+1 646 558 8656 US (New York)
+1 301 715 8592 US (Germantown)
Meeting ID: 836 7358 1282
Passcode: 542101
Find your local number: https://us02web.zoom.us/u/kzyVFAssf

STORMWATER MASTER PLAN

Update and Text Amendment

PTA 21-0001

Tonight's Presentation

1. Overview of Stormwater Master Plan
2. Proposed Plan Text Changes
3. Applicable Criteria
4. Conclusion

Stormwater Master Plan

Scope of Master Plan:

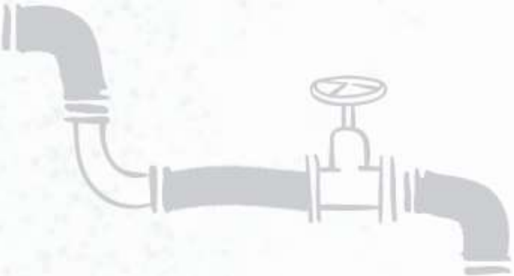
- Replaces 1972 Tualatin Drainage Plan;
- Updated technical analysis including city growth and development
- Capital improvements;
- Programmatic approaches (maintenance, vegetation management);
- Policy recommendations.

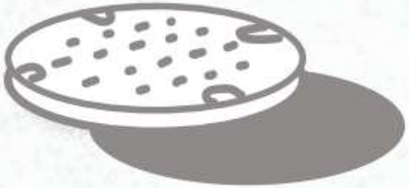
Stormwater Master Plan

100
page master plan to support us over the next 10 years of growth

21
Projects to support waterbodies in Tualatin

1900
linear feet of pipe to be installed





30
manhole covers to install, replace, or add

Stormwater Master Plan

Aims:

- Increase capacity;
- Address erosion;
- Increase water quality treatment;
- Address pollutant sources and/or improve treatment functions;
- Easier to maintain our stormwater system.

Stormwater Master Plan

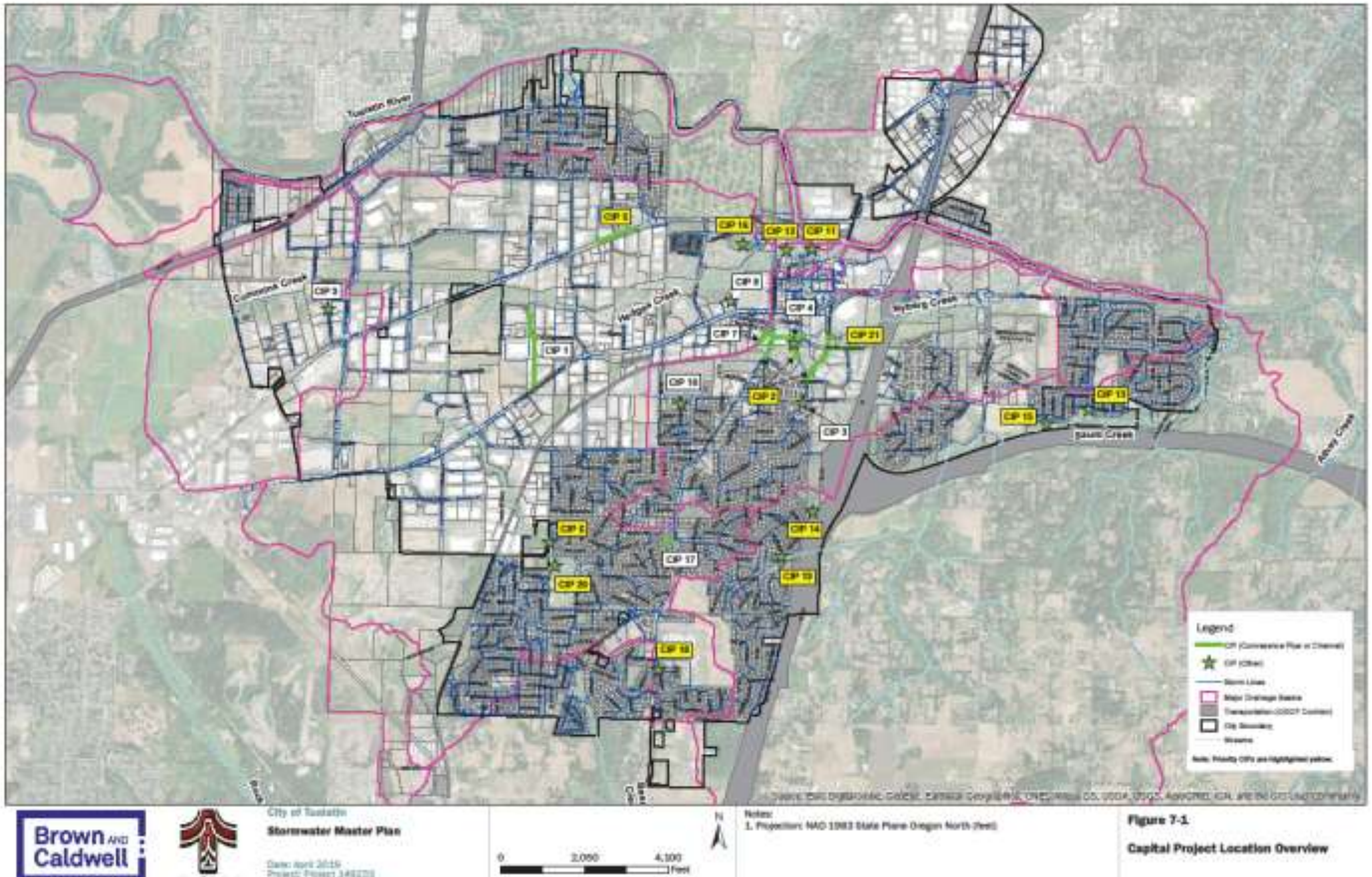
- **Infrastructure:** Repair and Replacement of Pipes + Structures
- **Maintenance:** Increase frequency of routine Public Water Quality Facility maintenance
- **New Stormwater Treatment:** Identification and construction of Public Water Quality Facilities to treat previously untreated stormwater
- **Environment:** Remove, manage, and assess invasive vegetation and physical condition of stream channels
- **Personnel:** Increase staff resources to support inspection of single family Low Impact Development Applications (LIDA)

Stormwater Master Plan

The Stormwater Master Plan includes information on how the stormwater programs will be funded and supported financially, which includes:

- Utility Rates
- System Development Charges

Stormwater Master Plan



Proposed Plan Text Changes

- Update Comprehensive Plan Chapter 9;
- Update capital project map;
- Update references to Stormwater Master Plan in Comprehensive Plan and Development Code.

Applicable Criteria

- Statewide Planning Goals;
- Oregon Administrative Rules;
- Metro Urban Growth Management Functional Plan;
- TDC 33.070, Plan Amendments.

Conclusion

- The findings demonstrate that the proposal meets the applicable criteria.
- Staff recommends the Tualatin Planning Commission forward a recommendation of approval of the proposed amendments (PTA 21-0001) to the City Council.
- Questions?

CITY OF TUALATIN
Staff Report

TO:	Tualatin Planning Commissioners
THROUGH:	Steve Koper, Assistant Community Development Director
FROM:	Jonathan Taylor, Economic Development Manager
DATE:	January 21, 2021

SUBJECT:
A presentation on the City of Tualatin's urban renewal efforts.

EXECUTIVE SUMMARY:
Background
Starting in December 2018, the City of Tualatin began a multi-phased process to work towards community revitalization and development of financing tools – beginning with the Tualatin 2040 Project.

Foundation

Beginning in December 2018, the City began the Tualatin|2040 initiative with the intent of providing a needs analysis for economic and residential short and long-term development, along with a code modernization effort.

Phase 1: Education Series.

This four-part series provided an overview of urban renewal and tax increment financing; the history of Tualatin's urban renewal areas, and how to close down an urban renewal area; what to do with the remaining assets of Central Urban Renewal District and Leveton Tax Increment Finance District; and to explore the feasibility of new districts based on Council-identified community and economic development goals.

Phase 2: Urban Renewal Area Official Closure.

In January 2020, the City Council and Tualatin Development Commission completed the closure of the Central Urban Renewal District (CURD), transferred remaining assets to the City of Tualatin, and adopted the final report on CURD.

Phase 3: Technical Study of the Feasibility of Urban Renewal Areas.

On September 28, 2020, the City Council approved the feasibility studies for the proposed areas of District 1 and District 2 and directed staff to present a project timeline for implementation of these districts.

On November 23, 2020 City Council approved the project timelines associated with Leveton, District 1 and District 2 urban renewal areas.

AREA TIMELINES

Leveton Tax Increment District Plan Amendment
November 2020 – March 2021

The goal is to amend the District's Plan Document to expend remaining funds on identified area projects. Projects already identified: future urban renewal planning.

District 1: Basalt Creek & Southwest Industrial Concept Plan
January 2021 – September 2021

Goal: To develop an urban renewal plan to finance and implement identified projects from area development plans – Basalt Creek Concept Plan, SW Industrial Concept Plan, Transportation System Plan, Tualatin|2040, Tualatin Moving Forward, etc.

District 2: I-5 Corridor, Tualatin Sherwood Road, Town Center Area
*March 2021 – 2022**

The City of Tualatin will begin to develop area goals and design and implement a town center/urban renewal plan for the proposed area. The Council will consider the following questions this year:

1. What is the area now?
2. What do we want the area to be/what is our vision for the area?
3. How can we implement that vision?

To learn more about Tualatin's urban renewal, visit www.tualatinoregon.gov/economicdevelopment/urban-renewal

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ATTACHMENTS:

- Attachment A - Presentation

tualatin | urban renewal

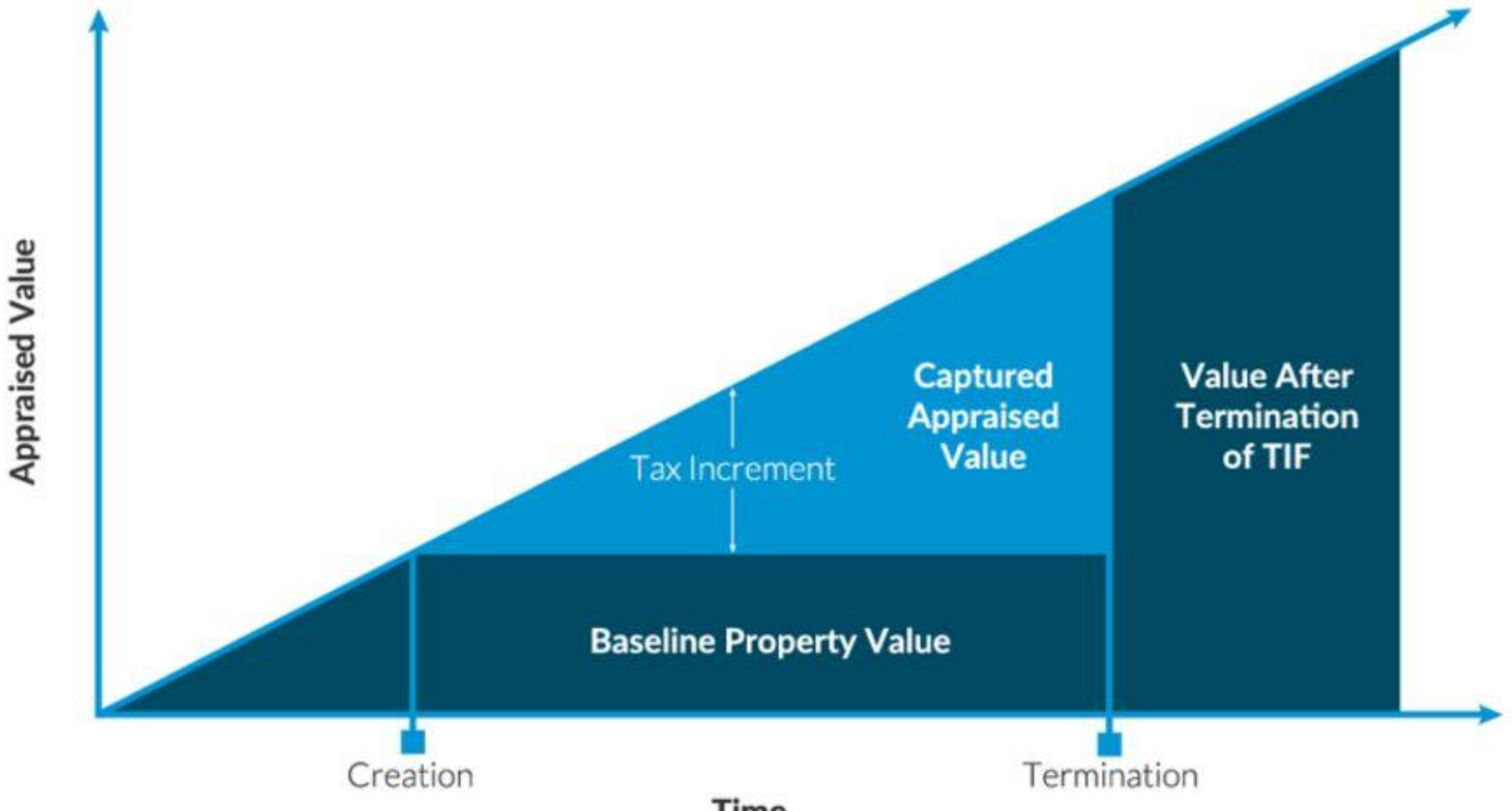
Stakeholder Kickoff

What is Urban Renewal?

A financial tool that funds projects and activities in an urban renewal area which have been identified in an urban renewal plan. The purpose of urban renewal is to make public investments in designated geographic areas to remove blight, to improve property values, and to leverage private investment. Public investments spur redevelopment in areas where it might not otherwise occur

How is Urban Renewal Financed?

Urban renewal uses tax increment financing to improve and redevelop designated areas of a city by reinvesting the area’s property taxes. *NOT NEW TAXES*



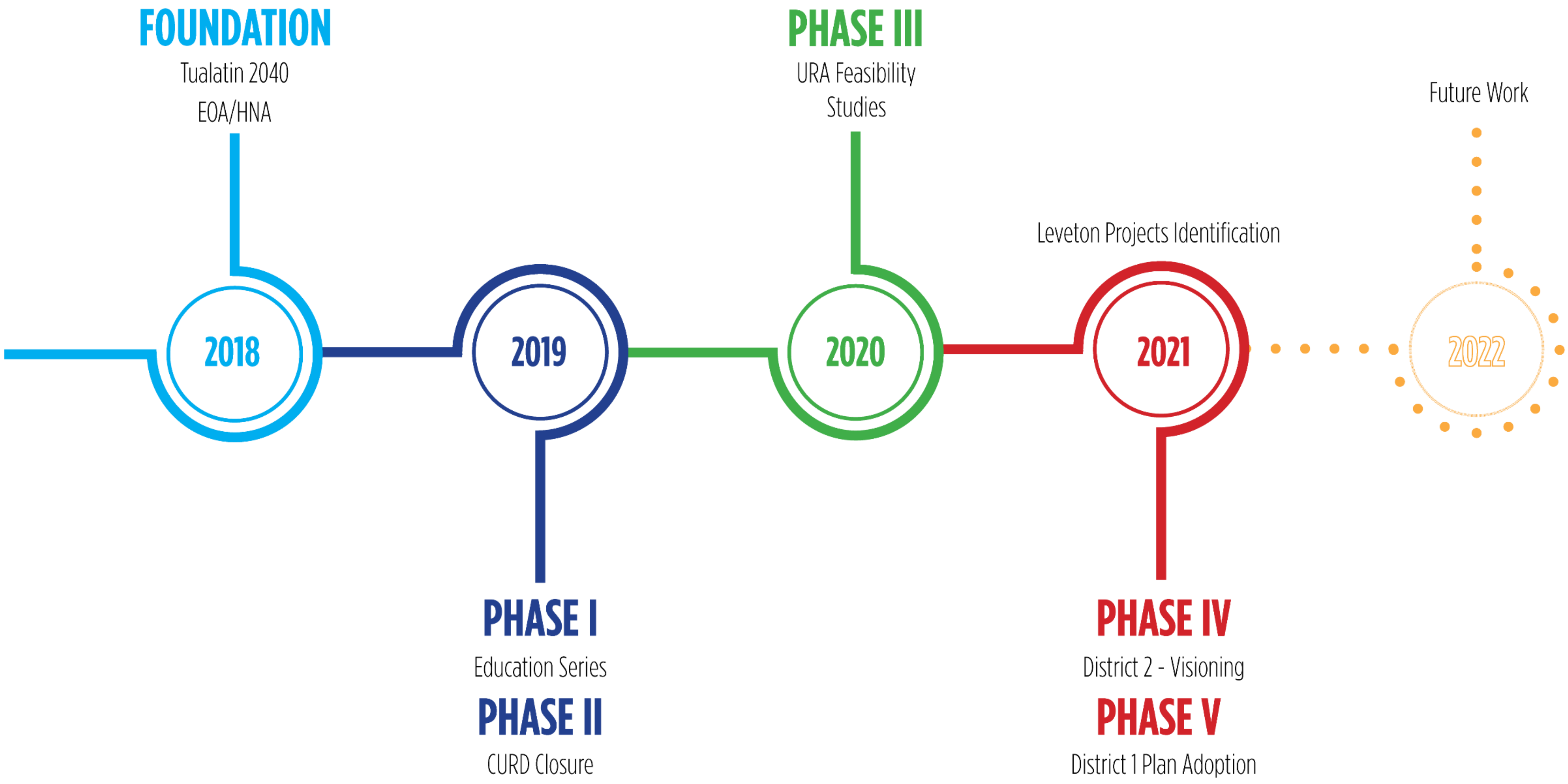
Who manages Urban Renewal?

The **Tualatin Development Commission** (Commission) is a separate municipal corporation responsible for governing Tualatin's one urban renewal area. The Commission provides direction and approval for projects and programs to invest in and improve specific geographic areas of the City.

The Commission is constituted by the Mayor and City Council with the Mayor acting as Chair. The City Manager serves as the **Executive Director** of the Commission

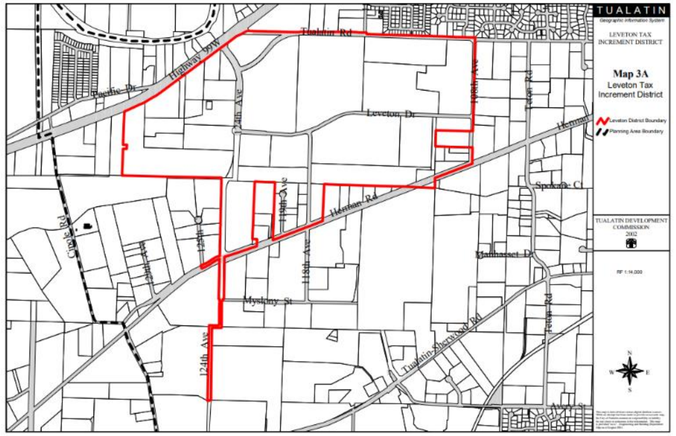
Staff support is provided by the Economic Development Department.

Phased Timeline

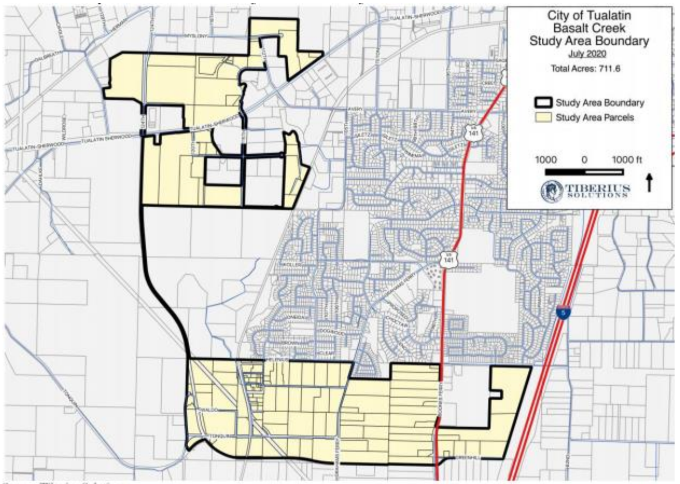


PROJECT AREAS

LEVETON TAX INCREMENT DISTRICT

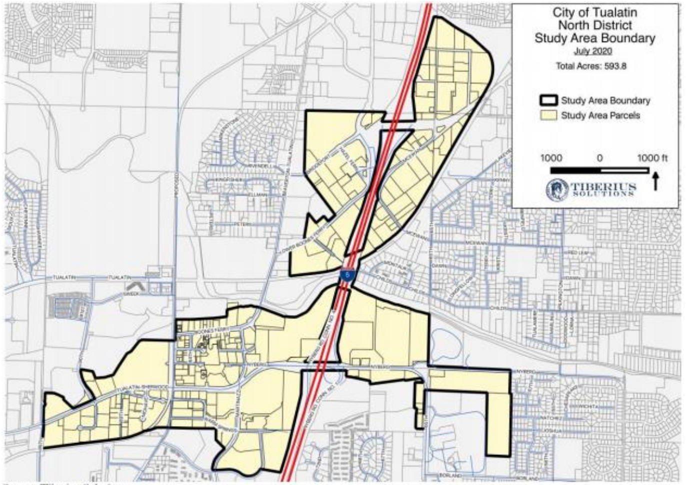


DISTRICT 1: BASALT CREEK / SW AREA



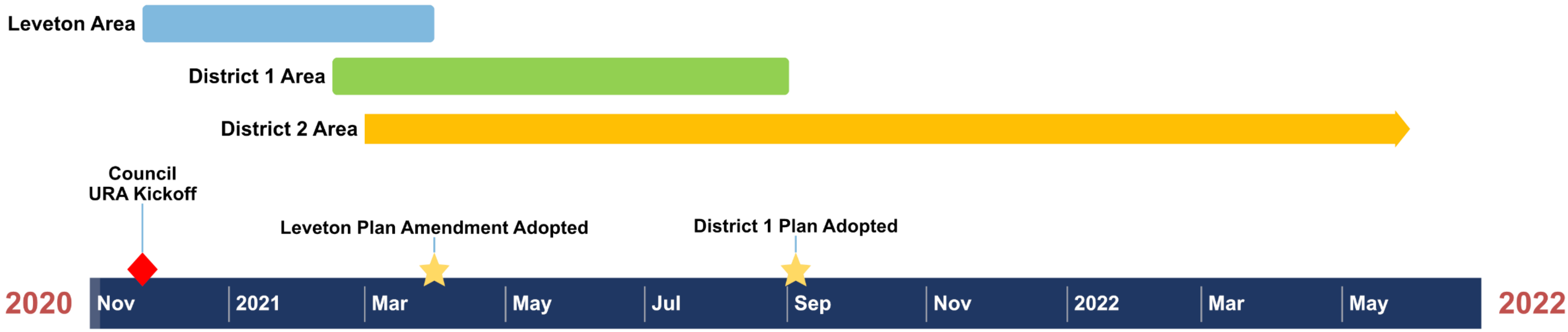
Source: Tiberius Solutions

DISTRICT 2: NORTH AREA



Source: Tiberius Solutions

OVERALL TIMELINE



Community Engagement

LEVETON TAX INCREMENT DISTRICT

- Staff Advisory Committee
- Area Outreach (*in progress*)

DISTRICT 1: BASALT CREEK / SW AREA

- Taskforce Committee
- Stakeholder Meetings
- *Planning Commission*
- Overlapping Tax Districts
- Community Forum

DISTRICT 2: NORTH AREA

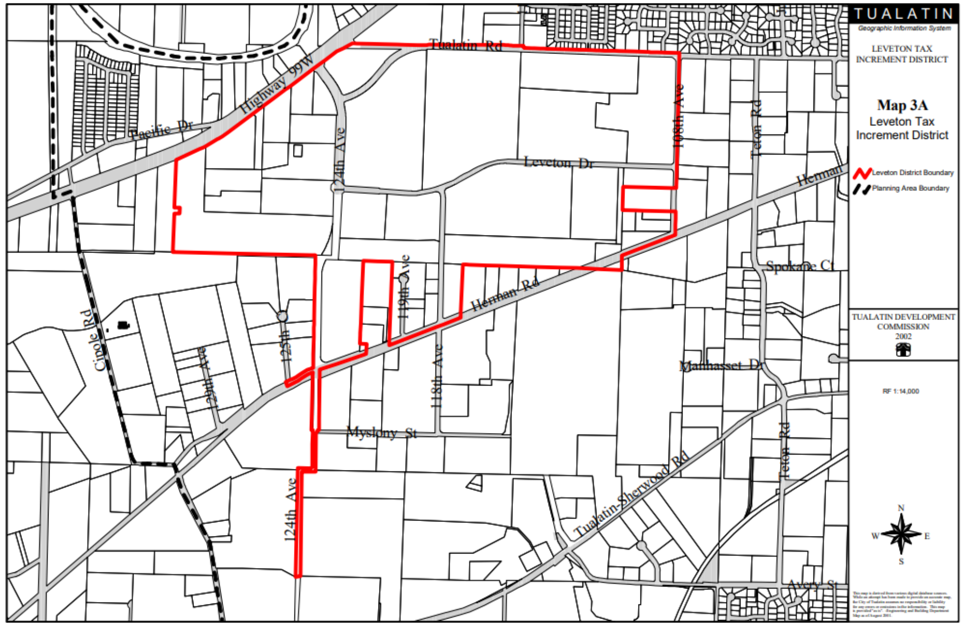
- Staff Advisory Committee
- Council Visioning
- Community Visioning
- Further Public Engagement TBD

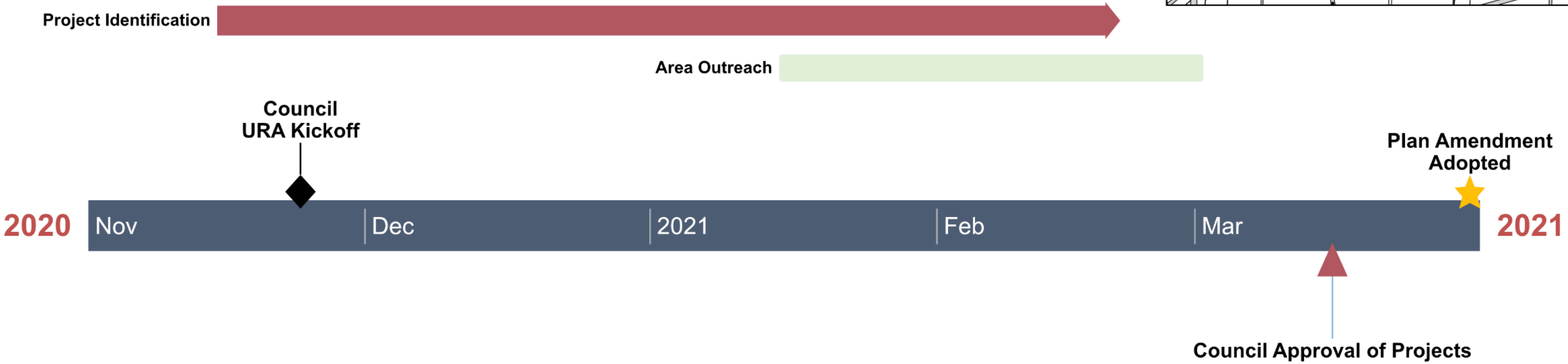
Leveton Tax Increment District Plan Amendment

Project Goal: To amend the Plan Document to expend the remaining funds on identified projects.

Already Identified:

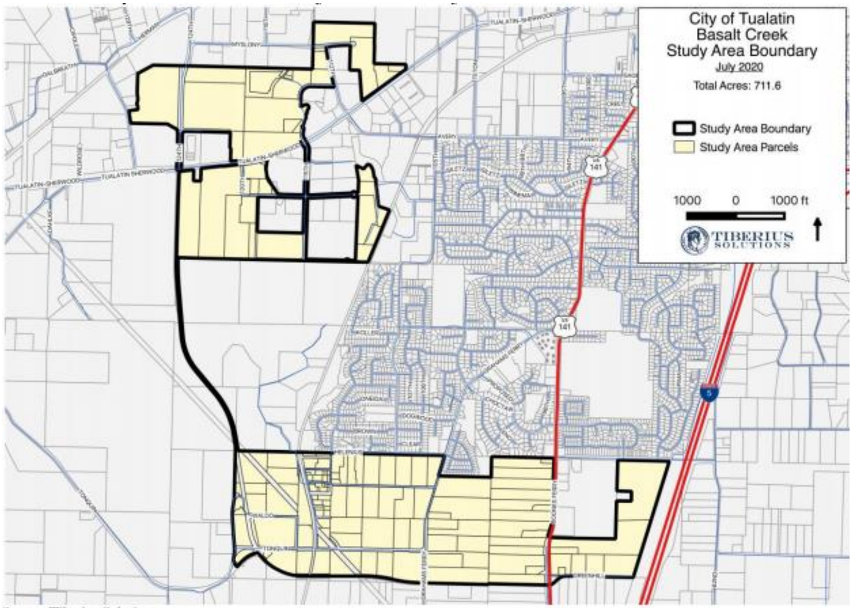
- Future URA District Planning





District 1: Basalt Creek Area, Southwest Industrial Concept Area

Project Goal: To develop an urban renewal plan to finance and implement identified projects from area development plans – Basalt Creek Concept Plan, SW Industrial Concept Plan, Transportation System Plan, Tualatin|2040, Moving Forward, etc.



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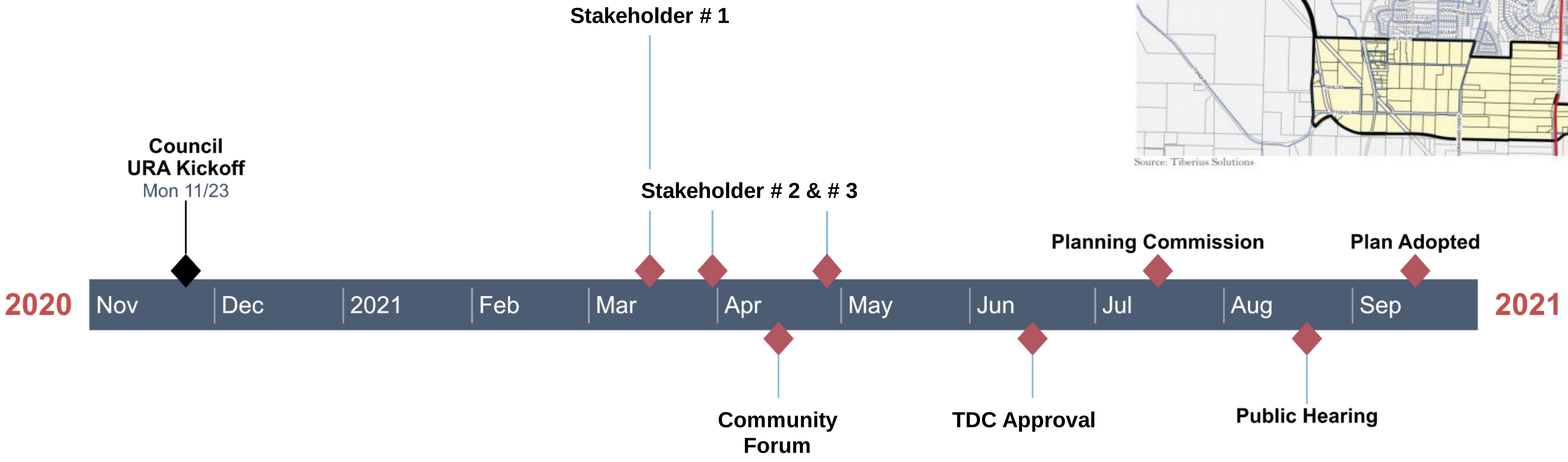


District 1: Stakeholder Task Force

OVERVIEW:

To advise the Tualatin Development Commission on District 1 Plan Development. Not required, but best practice.

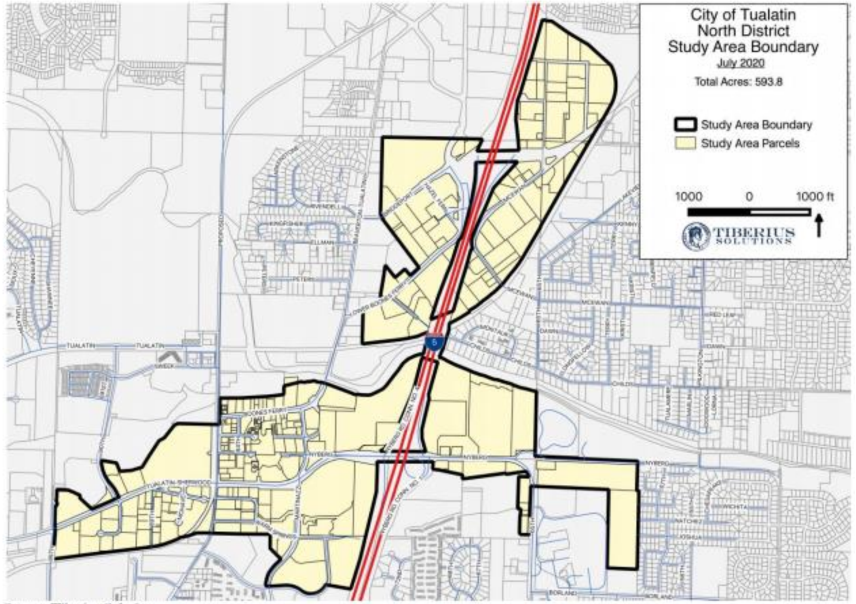
STRUCTURE:

- Up to seven (7) members:
  - 4 property owners, 1 Tax District Rep, 1 Plan. Comm., 1 City Council Member
- Term, Resolution ends September 2021
- Duties:
  - Review urban renewal plan boundary and make recommendations;
  - Identify and recommend projects in the proposed area;
  - Review financial analysis and impacts of the proposed district and project.

District 2: Town Center Area, I-5 Corridor, Tualatin-Sherwood Road

Questions for Consideration:

- Understand what is the area now?
- What vision do we have for the area?
- How can we implement that vision?



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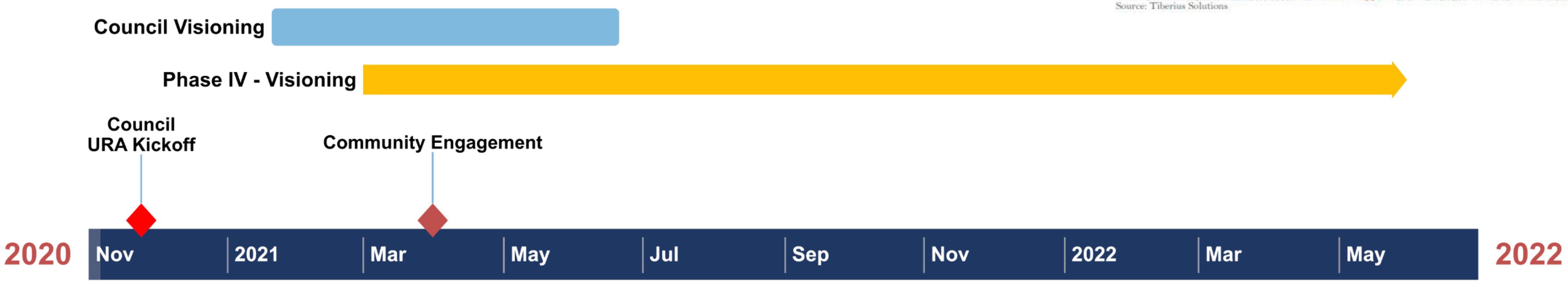

NEXT STEPS
60-DAY MILESTONES:

Leveton:

1.) URA 101 for Internal Staff Advisory Team

2.) Finalize Project Identification – Staff

District 1:

1.) Stakeholder Taskforce Resolution - Done

2.) Stakeholder Task Force Solicitation – In progress

QUESTIONS AND DISCUSSIONS?