Technical Memorandum

Date: February 8, 2021

Project: Cooper Mountain Utility Plan

To: Sheila Sahu, PE, LEED AP BD+C
City of Beaverton

From: Andrew Henson, P.E.
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Re: Sewer Alternatives Development

Introduction

This memorandum describes the development of the preferred and alternative preliminary sanitary sewer alignments for Cooper Mountain. The following sections describe the planning, design criteria and assumptions, the projected sewer loads, and proposed connection points to existing or planned sanitary sewer systems. Information guiding the development of the preliminary alignments was obtained from Clean Water Services (CWS), City of Beaverton (City), and planning work conducted under the Cooper Mountain Community Plan (Community Plan).

Assumptions

High level assumptions for development of sanitary sewer alignments were documented in the Vision Statement and Guiding Principles memorandum (Murraysmith, 2020). These assumptions include planning-level requirements related to placement of alignments, average daily flow rates based on development type, methods and assumptions for calculating rainfall-derived infiltration and inflow (RDII), planning criteria for sewer conveyance design, and integration with systems in surrounding areas. These assumptions are discussed in further detail in the Vision Statement and Guiding Principles memorandum and the sections below.

Estimated Sewer Flows

Sewer flows were estimated for average daily sewer flows as well as for RDII.

Average Daily Sewer Flows

Development density and average daily sanitary sewer flow rates for various development types were based on estimates and methods from the 2015 South Cooper Mountain Sanitary Sewer Master Plan (SCMMP) and are summarized in Table 1 (David Evans and Associates, 2015). Parcels within the project area were categorized by development type using data from the Community Plan. Flows from portions of North Cooper Mountain (NCM) were assumed to be tributary to the alignments discussed in this memorandum. The NCM area was assumed to be fully developed, consisting of single-family neighborhood development.

Table 1 - Density and Average Daily Sewer Flows by Development Type

BLI Development Type	SCMPMP Development Type	Density (households/ac)	Average Daily Sanitary Sewer Flows (gal/d/unit)
F-CLN Future Cluster Neighborhood	Multi-family Neighborhood	26.53	178
F-CN Future Compact Neighborhood	F-CN Future Compact Neighborhood	12.61	247
F-HN Future Hillside Neighborhood	Low-density Hillside Neighborhood	4.01	300
F-SFN Future Single Family Neighborhood	F-SFN Future Single Family Neighborhood	6.24	300
F-UN Future Urban Neighborhood	Multi-family Neighborhood	26.53	178

The Buildable Lands Inventory (BLI) dataset provided by the City categorized the project area by percent constrained and development status and were used to determine the amount of developable land in each parcel (City of Beaverton, 2020). The percent constrained describes the percentage of area in each parcel that is physically constrained and considered unbuildable (e.g., due to steep slopes or proximity to streams).

Percent constrained is broken into the following four categories:

- Zero percent constrained – These areas are physically unconstrained and considered fully buildable.
- 50 Percent Constrained – 50 percent of the area is physically constrained, and 50 percent is buildable.
- 90 percent constrained – 90 percent of the area is physically constrained, and 10 percent is buildable.
- 100 percent constrained – This area is fully constrained and unbuildable.

Development status describes the level of existing or planned development within a given parcel and was broken into the following four categories:

- Vacant – The unconstrained area of these parcels is assumed to be fully developable.
- Developed – These parcels are considered fully developed and unavailable for additional development.
- Partially Vacant – These parcels contain both developed and vacant area. Developable area is calculated per the methods described in the BLI memorandum.
- Committed – This category includes parcels in common ownership, public and private rights-of-way (ROW), existing cemeteries, and public facilities and are considered unavailable for additional development.

Committed and developed parcels were not considered in this analysis as contributing sewer flows to the proposed alignments. The BLI also assumed a 25 percent set-aside in each parcel for ROW, stormwater facilities, and other public lands. These categorizations and computations are discussed in detail in the BLI memorandum.

The developable acreage is the total parcel area less the BLI categorizations of: 1) constrained area, 2) the previously developed area (if partially vacant), and 3) the set-asides. The sewer loading for a given parcel was then computed by applying the density and unit loading rate for the parcel's development type, as designated by the Community Plan, to the developable acreage. Table 2 summarizes the developable acreage for each development type and the projected total average daily flow for each development type.

Table 2 - Total Developable Acreage and Projected Total Average Daily Flow by Development Type

Development Type	Developable Area (ac)	Projected Total Average Daily Flow (mgd)
Future Compact Neighborhood	123.55	0.385
Future Single Family Neighborhood	138.35	0.259
Future Cluster Neighborhood	32.49	0.153
Future Urban Neighborhood	15.78	0.075
Future Hillside Neighborhood	53.70	0.065

Infiltration and Inflow

RDII for the project area was computed as described in Method 1 in the South Cooper Mountain System Analysis Technical Memorandum (HDR, 2019b). This method assumes an RDII rate of 4,000 gallons per acre-day applied to an area that is computed by multiplying the length of pipe between a given manhole and the next upstream manhole by a 50-ft-wide buffer.

RDII flow from the NCM area is computed as described in Method 2 in the South Cooper Mountain System Analysis Technical Memorandum. This method assumes 20% of the overall tributary area contributed to RDII loading. The rate of 4,000 gallons per acre-day is then applied to this 20% area to compute the RDII loading.

Design Criteria

Proposed alignments were designed based on the CWS design criteria (Clean Water Services, 2017) and the 2019 City of Beaverton Sewer Master Plan Update (HDR, 2019a). Table 3 provides a summary of the design criteria used for the proposed alignments.

Table 3 - CWS and City of Beaverton Design Criteria

Design Criteria	Value
Minimum Pipe Velocity (ft/s)[1]	2.0
Maximum depth/diameter (d/D)	0.8
Minimum Pipe Cover – Paved Areas (in)[2]	48
Minimum Pipe Cover – Un-Paved Areas (in)[2]	36
Manning's "n"	0.013
Minimum Pipe Diameter (in)	8
Minimum Slope[3]	0.4%
Maximum Slope[4]	20%
Downstream Pipe Offset (ft)	0.2

1 – When flowing full or half full.
2 – The "other" material category was used for selecting minimum cover to allow for the use of seismically resilient materials.
3 – Minimum slope is for the minimum pipe diameter of 8 inches. All pipes, regardless of diameter, were designed to the minimum slope.
4 – Maximum slope without the use of anchor walls or metal pipe slope anchors.

Sewer Alignment Alternatives

The following sections describe the proposed preferred and alternative sewer alignments.

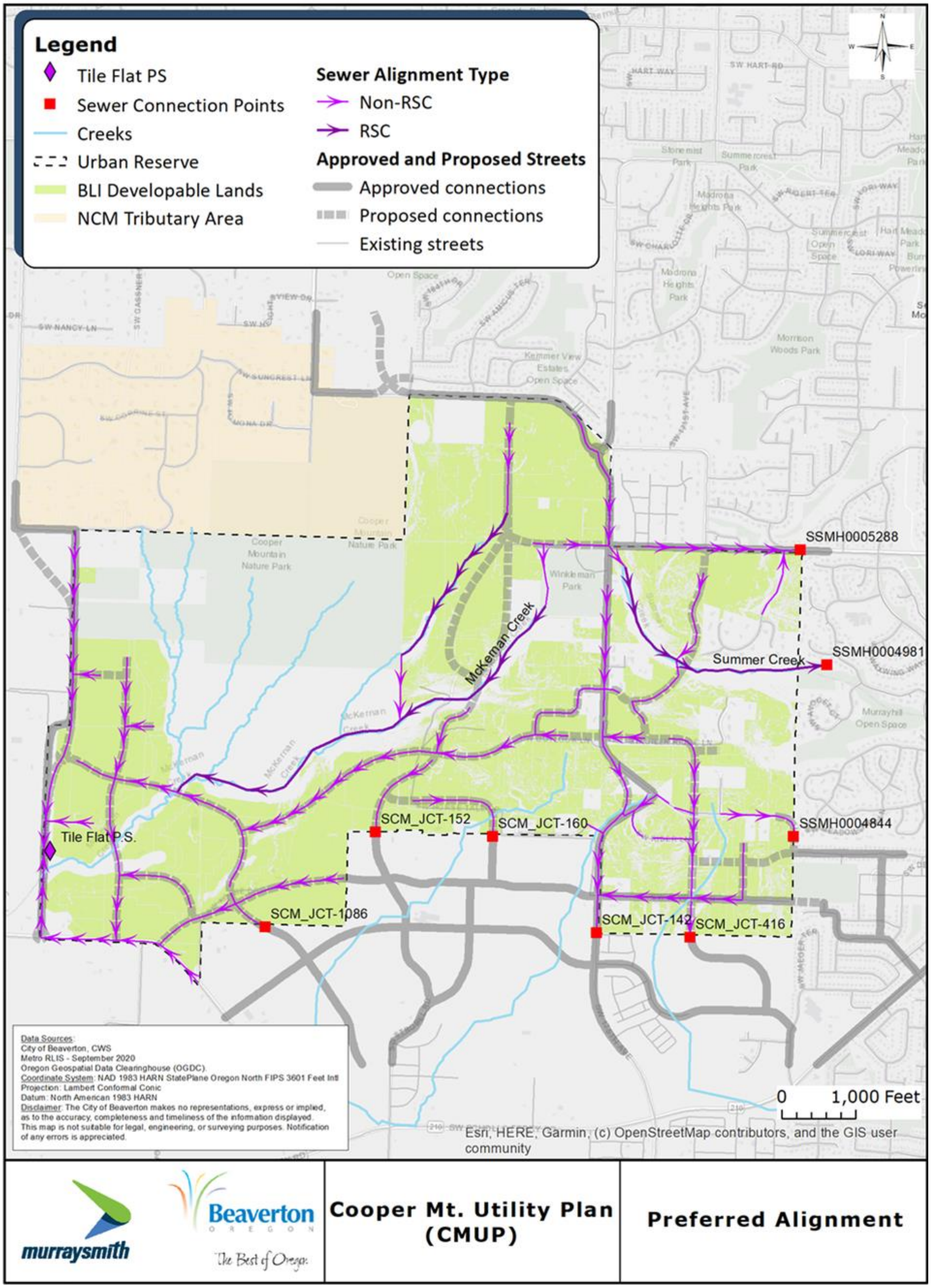
Preferred alignment

The preferred alignment is a combination of alignments located in resilient stream corridors (RSCs), where possible, and alignments along roadways. The location of alignments is primarily driven by the feasibility of RSCs and the BLI and were sited within the RSCs. Alignments along roadways were sited based on existing and planned roads and road profiles provided by the Community Plan. Placing the sewer alignment in the RSC allows the collection system to be at lower elevations than developable land, facilitating gravity flow. The preferred alignment also provides more options for crossing McKernan Creek but creates unconventional maintenance and access for pipes located within the RSCs.

The preferred alignment is subject to refinement as the road corridors and stormwater management strategy for the study area continue to evolve. The preferred alignment includes an extension of the existing sewer along Summer Creek which faces physical challenges due to topography as well as hydraulic constraints in the downstream system. If an extension of the existing sewer in this area is deemed infeasible, then serving this portion of Cooper Mountain by gravity conveyance would pose additional challenges. Alignments within RSCs comprise a significant portion of the preferred alternative. If RSCs are determined to be infeasible, the alternative alignment, described in the following section, would become the primary alignment.

The preferred alignment conveys flow to previously planned connection points in the existing or planned systems on the eastern and southern boundaries of the Cooper Mountain project area in addition to the planned Tile Flat Pump Station located in the southwest corner of the project area. Future analysis will evaluate the estimated average daily sewer flows and RDII from Cooper Mountain to ensure future flows align with the previously planned flow at the proposed connection points. The preferred alignment, developable lands, and the existing connection points are shown in **Figure 1**.

Figure 1: Preferred Sewer Alignment with Developable Lands



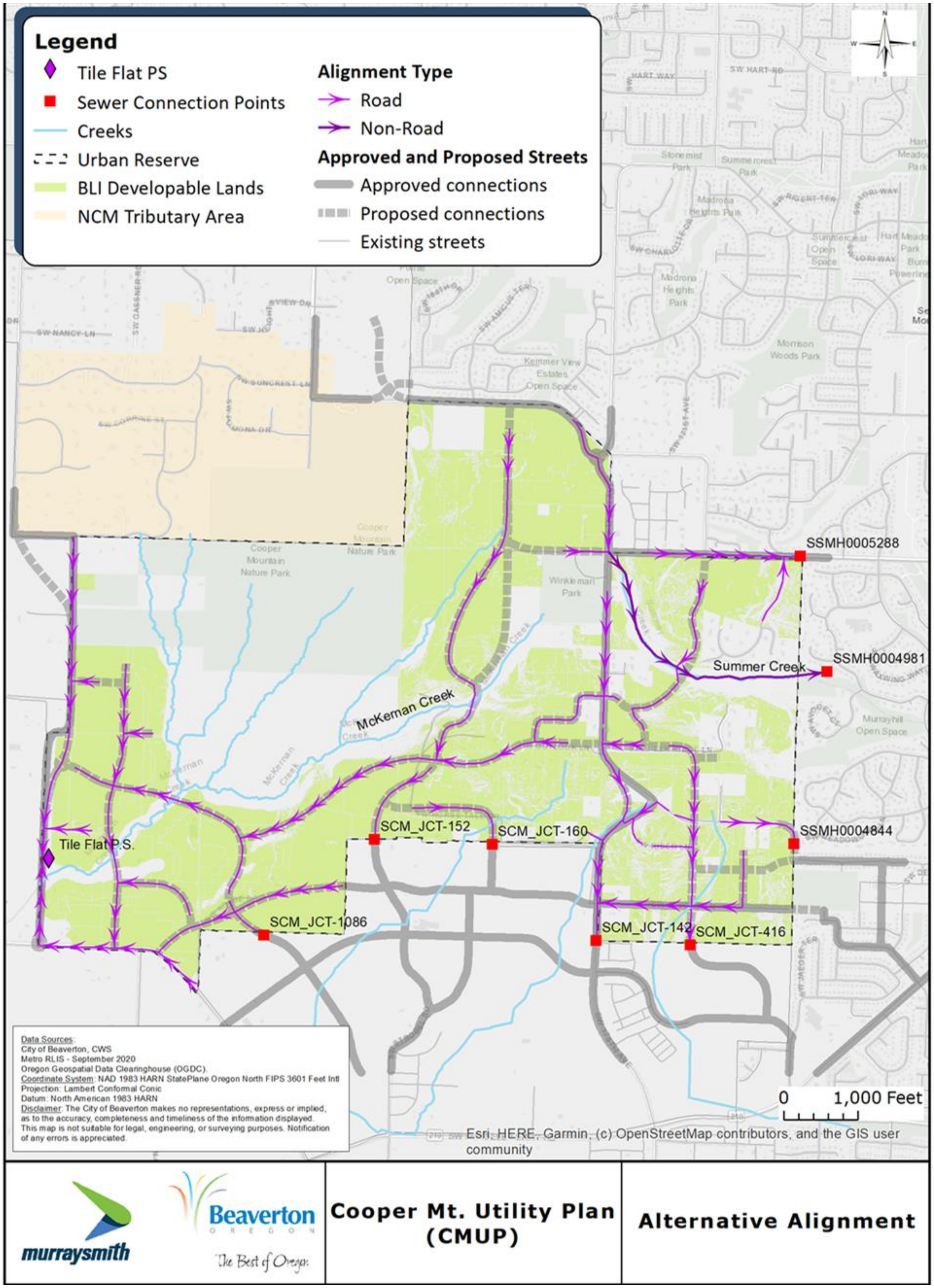
Alternative alignment

The alternative alignment is primarily sited along roadways with a single RSC alignment for Summer Creek. The location of the alignments prioritizes roadways where possible; the alignment along Summer Creek is necessary to serve this portion of the project area via gravity conveyance. Alignments along roadways were sited based on existing and planned roads and road profiles provided by the Community Plan. The alternative alignment provides conventional sewer alignments and ease of maintenance. However, crossing McKernan Creek using gravity conveyance creates challenges, with some stretches of the alignment sited relatively deeper than alignments elsewhere in the project area.

The alternative alignment is subject to refinement as the road corridors and stormwater management strategy for the study area continue to evolve. The alternative alignment also includes an extension of the existing sewer along Summer Creek which is challenging as noted in the previous section. If an extension of the existing sewer in this area is deemed infeasible, serving this portion of Cooper Mountain via gravity conveyance would be difficult.

The alternative alignment conveys flow to previously planned connection points in the existing or planned systems on the eastern and southern boundaries of the Cooper Mountain project area in addition to the planned Tile Flat Pump Station located in the southwest corner of the project area. Future analysis will evaluate the estimated average daily sewer flows and RDII from Cooper Mountain to ensure future flows align with the previously planned flow at the proposed connection points. The alternative alignment, developable lands, and the existing connection points are shown in Figure 2.

Figure 2: Alternative Sewer Alignment with Developable Lands



Conclusions and Recommendations

An analysis of data from the BLI determined the amount and distribution of buildable land within Cooper Mountain. Land use designations described in the Community Plan, in conjunction with density and per capita sewer loading rates applied in previous planning efforts in the Cooper Mountain area were used to compute estimated sewer loads. Two preliminary alignments Preferred and Alternative, were developed to provide sewer service to Cooper Mountain. The preferred alignment prioritizes alignments within RSCs, where feasible, while the alternative alignment prioritizes locating sewer along roadways.

It is recommended that the City move forward with the preferred alignment approach. Future analysis should consider any revisions to the feasibility of RSCs or the placement and design of proposed roads. The preliminary alignment conveys flow to previously planned connection points and were assumed to receive calculated flows from the project area. Future analysis will ensure flows from the project area align with the previously planned flow to the downstream connection points.

References

City of Beaverton. (2020). *Draft Buildable Lands Inventory.*

Clean Water Services. (2017). *Design and Construction Standards For Sanitary Sewer and Surface Water Management.*

David Evans and Associates. (2015). *City of Beaverton South Cooper Mountain Phase 1 - Sanitary Sewer Master Plan.*

HDR. (2019a). *City of Beaverton Sewer Master Plan Update.*

HDR. (2019b). *South Cooper Mountain and Rural Area Sewer System Analysis.*

Murraysmith. (2020). *Subtask 2.3, 3.3, and 4.3: Vision Statement and Guiding Principles – FINAL.*