City of Hillsboro
Capital Improvement Master Planning Services
Water Supply Evaluation Project

B&V Project No. 161661
B&V File No. E 1.8

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Date: December 7, 2011

RE: **Summary of Water Supply Development Options-*FINAL***

1.0 INTRODUCTION

The City of Hillsboro (City) is evaluating long term water supply options that will deliver 80 million gallons per day (mgd) of additional treated water for itself and its Joint Water Commission (JWC) partners. This technical memorandum (TM) is a summary of conceptual design development of these water supply options for the City of Hillsboro and other JWC partners. The non-consumptive water needs of Clean Water Services (CWS) are approximately 40 MGD and are also taken into account.

The project Scope of Work was developed by the City and the project team to identify potential options for long-term water supply; consider all reasonable options, and narrow down the field of options to the most realistic and cost-effective option or combination of options. The process includes the following steps:

1. Collect, organize, and utilize existing work completed by others to leverage resources (TM 01).
2. Develop hydrogeologic characterizations of certain areas to augment existing studies (TM 01).
3. Confirm/consolidate water supply needs (TM 03) and research water rights/water availability (TM 04).
4. Screen out options that have fatal flaws.
5. For alternatives remaining in the process, review and compare water quality data (TM 06).
6. Identify and assess permitting and environmental resource concerns (TM07).
7. Develop conceptual infrastructure plans (this TM08).
8. Develop cost estimates and perform financial analysis for future option comparison (TM 09).
9. Evaluate both qualitative and quantitative approaches to the evaluation of water supply options (TM 10).
10. Recommend a long-term water supply strategy for the City of Hillsboro (TM 11).
11. Publish final report for public review and input.

Initially, the following options were identified. The names given here are those used by the City in its public outreach efforts; the names in parenthesis are the original name of the options in the Scope of Work, and in prior technical memorandums.

- Tualatin Basin Water Supply Project (TBWSP) Option.
- Willamette-Wilsonville Option.
- Portland Supply Option.
- Willamette-Newberg Option.
    - Willamette – Newberg West Sub-Option.
    - Willamette-Newberg East Sub-Option.
- Northern Groundwater Supply Option.
- Durham Option.
- Willamette River Exchange.
- Aquifer Storage and Recovery (ASR).
- Conservation.

All but the first option provides additional M&I raw supply but do not supply additional raw water supply to Clean Water Services without augmentation by a smaller raise of the existing Scoggins Dam by Clean Water Services. The TBWSP includes both the M&I raw water supply as well as the Clean Water Services supply allocation for environmental flows.

From February through September 2010, the project team completed Steps 1 through 3 above, and began background work on Steps 5 and 6. At the September 2010 TAC meeting, City management team, the TAC, and the Black & Veatch (B&V) project team conducted Step 4, Screen Out Options That Have Fatal Flaws.

The following were screened out as major options and moved to bridging/long term augmentation strategies:

- Aquifer Storage and Recovery (ASR).
- Conservation.

Although ASR and conservation are potentially feasible and valuable resources, the amount of water obtainable from these options will not approach the 80 mgd needed by Hillsboro and its JWC partners, and will be only a partial or short-term solution. Regardless, the City will be pursuing them as long-term augmentation and emergency water supplies.

The following options were dropped from further consideration:

- Durham Option.
- Willamette River Irrigation Exchange.

It was determined that the Durham option will be too difficult or impossible to obtain water rights on the Tualatin River in the amount needed. Details of the analysis are presented in *TM 4, Water Rights Review of Water Supply Options,* GSI, November 2010.

The Willamette River Irrigation Exchange option proposed that the Tualatin Valley Irrigation District (TVID) trade their stored agricultural water in Hagg Lake to the TBWSP for municipal and industrial (M&I) use in exchange for the supply that the TBWSP would obtain from the Willamette River. It was determined that for the Willamette River Exchange option, legal and regulatory mechanisms did not exist for the transfers of water between the two entities. Details of the analysis are presented in *TM 4, Water Rights Review of Water Supply Options,* GSI, November 2010

The remaining six water supply options were retained for further analysis. That analysis included Items 5, 6, and 7 in the above scope – Review water quality, permitting and environmental resource concerns, and develop conceptual infrastructure plans. Drawing from previous work in existing reports and with two additional developed supply options, the level of design completion varies from a conceptual level to a planning level depending on the source of information. Readers should also note that the TBWSP, to date, has had a much higher level of work performed and background information developed than the other options.

Six water supply options are evaluated in this TM:

1. **Tualatin Basin Water Supply Project (TBWSP) Option**. This option would reconstruct Scoggins Dam, improving its seismic resistance capability and raise the reservoir pool by 40 feet to provide additional storage in Hagg Lake. It would also include a new water treatment plant parallel to the existing plant, a new raw water pipeline for both filling and draining the reservoir, a new raw water pump station to supply both the JWC water treatment plant and reservoir fill demands independently, finished water pipeline system, and finished water storage improvements.
2. **Willamette-Wilsonville Option**. Surface water from the Willamette River would be treated by expanding an existing water treatment plant at Wilsonville and pumping through a new water transmission pipeline system to the Hillsboro/ JWC supply system.
3. **Portland Supply Option.** Finished water would be purchased from the Portland Water Bureau (PWB) and conveyed from Powell Butte Reservoir through an expanded transmission pipeline system to the Hillsboro/ JWC supply system. A new water treatment plant would be constructed to remove chloramines and turbidity prior to entering the Hillsboro water distribution network**.**

4. **Willamette-Newberg West Sub-Option.** Surface water from the Willamette River would be treated in a new treatment plant near Newberg and pumped through a new transmission pipeline along a western alignment to the Hillsboro/ JWC supply system.

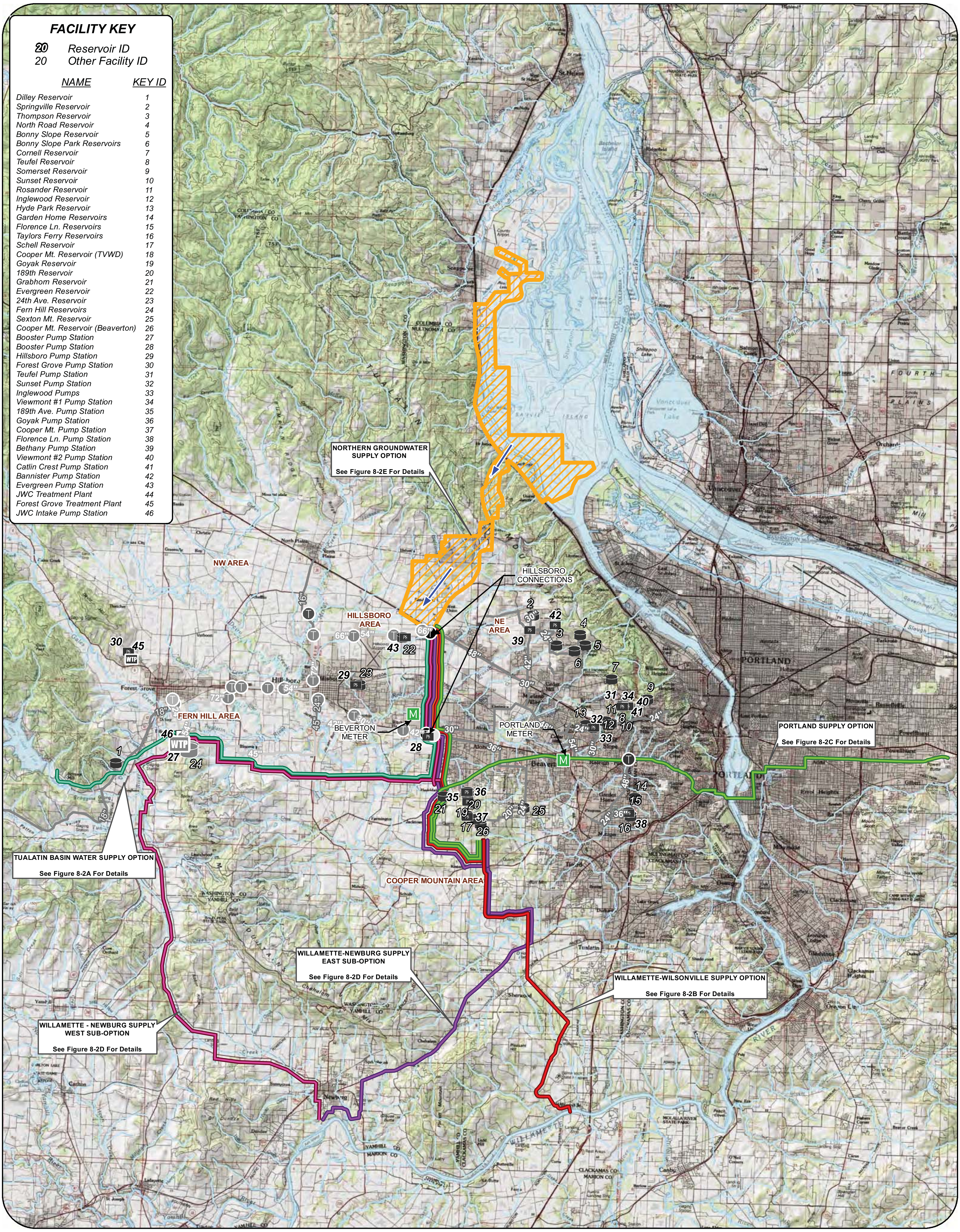
5. **Willamette-Newberg East Sub-Option.** Surface water from the Willamette River would be treated in a new treatment plant near Newberg and pumped through a new transmission pipeline along an eastern alignment to the Hillsboro/ JWC supply system.

6. **Northern Groundwater Supply Option.** Groundwater from new collector wells constructed east of Scappoose would be treated in a new water treatment plant near Scappoose and pumped through a new pipeline over Cornelius Pass and into the Hillsboro/JWC supply system.

An overall map of the water supply options is shown in **Figure 8-1**.

References to technical memorandums and additional information included in the appendixes of this TM are listed below:

- **Appendix A – Conceptual Ground Profiles and Hydraulic Gradelines**. Provides the conceptual-level ground profiles and hydraulic gradelines from the source along the selected alignment to the termination points for each water supply option evaluated.
- **Appendix B – Conceptual Pump Station Energy Use Calculations**. Provides the pump station energy use assumptions and calculations for all options.
- **Appendix C**
  - **C1.1 - Northern Groundwater Supply Option TM** (prepared by CH2MHill). Detailed TM evaluating the Northern Groundwater Supply Option.
  - **C1.2 - Updated Hydrologic Evaluation and Water Rights Review of Northern Groundwater Supply Option** (prepared by GSI Water Solutions). An addendum to the original Hydrologic Evaluation and Water Rights Evaluation of Northern Groundwater Supply Option TM.
- **Appendix D – Abbreviations List**. The list of abbreviations used in this TM.



LEGEND

FACILITIES

- JWC Intake
- JWC Pump Station
- JWC-Member Pump Station
- JWC Reservoir
- JWC-Member Reservoir; City of Beaverton
- JWC Treatment Plant
- JWC-Member Treatment Plant
- ASR Well
- Beaverton Turnout
- Forest Grove Turnout
- Hillsboro Turnout
- North Plains Turnout
- TVWD - Portland Water Bureau Turnout
- TVWD Turnout
- JWC Meter
- Proposed Pump Station
- Proposed Reservoir
- Proposed Water Treatment Plant

PIPES

- JWC Transmission Main
- JWC-Member Transmission Main
- Portland Supply Option
- Willamette - Wilsonville Supply Option
- Willamette - Newburg Supply
- West Sub-Option
- East Sub-Option
- Tualatin Basin Water Supply Option
- Hillsboro North Connection
- Northern Groundwater Supply Option Corridor

- JWC ASR Development focus Areas
- ASR Study Area
- Waterbody
- River

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FIGURE 8-1

WATER SUPPLY OPTIONS

HILLSBORO WATER

Project No.: 161669
Sources: Joint Water Commission (JWC)
City of Hillsboro
Tualitin Valley Water District (TVWD)
Washington County
Metro Data Resource Center

N

1 0 1 2 3 Miles

December 7, 2011

2.0 REQUIRED WATER SUPPLY CAPACITY

The *2009 JWC Master Plan* prepared by Black & Veatch (B&V) projected the 2050 JWC Maximum Day Demand (MDD) to be 180 mgd. Three planned expansions of the JWC Water Treatment Plant (WTP) would increase the plant capacity from 75 mgd to 175 mgd. The remaining required capacity would be provided through an aquifer storage and recovery (ASR) program. ASR will be used to provide smaller incremental increases in capacity in both the short and long term, in addition to the options included in this TM.

Key to the planned JWC WTP expansion is participation in the TBWSP which would raise Scoggins Dam and increase the capacity of Henry Hagg Lake[1]. Additional storage from the TBWSP would provide the additional raw water supply required for the JWC WTP expansion. Seismic upgrades will be required for the existing Scoggins Dam regardless of the supply option selected. Each existing contract holder in Henry Hagg Lake will be required to participate financially in these mandatory upgrades. As currently established, the local share is expected to remain at 15 % of costs, with the federal government paying the other 85% of the cost. All entities with contracts for water impounded by Scoggins Dam will be required to participate in the funding of the local share.

In February 2011, the City of Hillsboro worked with B&V to update the 2050 projected JWC MDD from 180 mgd to 151 mgd. The primary reason for the demand reduction was the result of reductions in the proposed Urban Reserve areas as compared to what was originally estimated during the 2009 JWC Master Plan effort. Urban growth planning discussions are still on-going between the City and regional government but material changes are not expected from what is being proposed at this current time.[2] Therefore, with 75 mgd of existing capacity at the JWC WTP, an additional 76 mgd is required to meet the projected demand. This additional required water supply has been rounded up to 80 mgd and is the figure adopted for the rest of this TM. All options except the TBWSP option include a smaller raise of Scoggins Dam to supply the future need of CWS. Supply provided by the ASR program is not included in this total, but when developed, this additional supply would be considered in the phasing of supply capacity projects in the future. All of the options presented will meet the year 2050 projected demands of the City of Hillsboro, JWC and CWS.

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[1] The TBWSP 40-foot dam raise is described in a *Conceptual Level Design Technical Memorandum* by Kleinfelder dated October 2010.

[2] The JWC WTP has a listed capacity of 75 MGD which is being evaluated by another consulting firm as part of a potential incremental plant expansion project. Any increase in capacity would decrease the amount needed from alternate supply alternatives. The expansion analysis will not be completed in time for inclusion into this report and the potential capacity gains at the JWC WTP would not materially change rankings in the alternative selection process. Therefore, this report continues to assume 75 MGD as the capacity of the existing JWC WTP.

3.0 ALTERNATIVE WATER SUPPLY OPTIONS AND INFRASTRUCTURE NEEDS

This section discusses the alternative supply options and their infrastructure requirements. Options 1 to 3 (TBWSP, Willamette-Wilsonville, Portland Supply) were alternatives originally developed by Carollo Engineers and Red Oak Consulting in February 2010. The details of the alternatives were limited and have been further developed as part of this TM. They have been adjusted to supply a revised additional capacity requirement of 80 mgd. Options 4, 5, and 6 (Willamette-Newberg West, Willamette-Newberg East, Northern Groundwater Supply) are additional alternative supply options developed by the City of Hillsboro, its JWC partners, B&V, and its subconsultants for the current project. These options are discussed in detail in this section.

For each option except the TBWSP Option, a smaller dam raise project is needed to provide water for Clean Water Services. The second would raise the water surface by 12.5 feet if the dam is reconstructed at its current location or 7.5 feet if a new dam was constructed downstream. This shorter raise would provide the 40 mgd needed for Clean Water Services future supply needs.

Each of the supply options requires construction of a large-diameter transmission pipeline. It is possible to phase transmission pipeline installation by building portions of the transmission line (at full diameter) over time although those built assets will be stranded until the entire pipeline is complete. Analysis of transmission line phasing is beyond the scope of this initial effort and, therefore, it is assumed the transmission pipeline will be constructed with its full diameter and length before any portion of the supply can be delivered. The treatment plant component of each supply option can be constructed in phases as required to meet growing demand over time.

Treatment processes identified for each water supply option in Technical Memorandum 06 have been included in this technical memorandum. All options assume that the existing JWC WTP peak capacity of 75 mgd would be maintained/achieved, and that already planned capital and deferred capital expenditures would take place and components not meeting their rated capacities would be improved to meet this overall 75 MGD capacity assumption. The JWC WTP would also be upgraded to address seismic concerns, provide standby power, and to implement ozone treatment.

Before construction of a transmission pipeline and between each treatment plant phased expansion, ASR could be used to provide bridging incremental increases in supply.

For each option except the TBWSP Option, conceptual-level ground profiles and hydraulic gradelines along the selected alignment are included in **Appendix A.** Additionally for these options, conceptual-level pump station energy uses were also calculated and are shown in **Appendix B**.

3.1 Option 1 - TBWSP Option

This option would require TBWSP participation to reconstruct Scoggins Dam, improving its seismic resistance capability (local participation is expected to be 15% of that specific cost) and raising the reservoir pool by 40 feet to provide additional storage in Hagg Lake (satisfying project demands for both the JWC and CWS). The JWC would expand its existing water treatment plant, add 15.1 MG clearwell, treated water storage reservoir, and transmission system to deliver its share of the expanded supply. This option included the addition of a new treated water storage reservoir to make comparison with the other options equal.

Options 1 includes the following components and are shown in **Figure 8-2A**:

- The raw water intake would have 155 MGD capacity for pumping to the JWC WTP and a range of 65 to 215 MGD capacity for back-pumping during the winter months to fill Henry Hagg Lake. The intake configuration pre-design work is being conducted by a partner led design team.
- The existing water treatment plant capacity would be expanded from the current 75 MGD to 155 MGD by a parallel conventional plant on the existing JWC WTP property above the 100-year flood plain.
- A 96-inch diameter, 7.2 mile (38,000 feet) long epoxy lined and coated welded steel raw water pipeline will interconnect the raised and renovated dam, the JWC WTP, and the new raw water intake. The pipeline will have in-line butterfly valves with small bypass relief/drain valves, air relief/air inlet valves, drain valves and will primarily be located within obtained easements outside of the roadway rights-of-way.
- Finished water conveyance pipelines from Fern Hill Reservoirs to Hillsboro Connection:
  - Mortar lined and coated welded steel.
  - 48-inch to 60-inch diameter. Total pipeline length: 99,400 Feet (18.8 miles)
  - In-line butterfly valves with small bypass relief/drain valves, air relief/air inlet valves, drain valves.
  - Preliminary location of the finished water transmission line is generally located in existing public rights-of-way. Where this is not possible, transmission lines proposed to be outside of existing public rights-of-way will be within easements to be obtained in the future.
- New Fern Hill Reservoir: 20 MG. All options include the construction of a new covered finished water reservoir to bring the total combined storage up to 60 MG. Currently the existing Fern Hill site owned by the JWC does not have sufficient room for another 20 MG reservoir. Therefore, an adjacent site on Fern Hill will need to be purchased. Having an additional 20 MG of storage in close proximity to the JWC WTP may affect the sizing of the planned 15.1 MG clearwell at the plant. However, analysis of clearwell capacity versus storage capacity is beyond the scope of this initial work and should be evaluated further if this option is selected for further analysis.
- Transmission booster pump station will be included with the JWC WTP expansion to increase the capacity of the existing south transmission line.

3.2 Option 2 - Willamette-Wilsonville Supply Option

According to the *Willamette Water Treatment Plant Master Plan*, MWH, 2006, there is enough room on the upper site to build up to 100 mgd in additional capacity. Therefore, this option proposes the existing Willamette River Water Treatment Plant (WRWTP) at Wilsonville would be expanded to provide 80 mgd additional treatment capacity for the JWC or future water supply entity serving the funding partners. As presented in the *2006 Master Plan*, MWH, the capacity of existing intake components includes the following:

Table 1. Willamette Water Treatment Plant Intake Component Capacities

Component	Total Existing Capacity	Wilsonville and Sherwood Capacity	TVWD Available Capacity Share
Intake Screens	70 mgd	25 mgd	45 mgd (1)
Raw Water Intake Pipeline (76-inch diameter)	120 mgd	25 mgd	95 mgd
Raw Water Pump Station Structure	120 mgd	25 mgd	95 mgd
Raw Water Pump Station Pumps	15 mgd	15 mgd	0 mgd

Note: Available capacity can be increased by replacing existing in-river tee-screens with larger diameter screens.

Existing intake facilities would be integrated into a new 80 mgd treatment plant constructed at the existing treatment plant site.

The 80 mgd flow would then pass through a large-diameter transmission pipeline to a new 20 MG terminal reservoir at Cooper Mountain. From the terminal reservoir a smaller-diameter transmission pipeline would deliver 36 mgd to the City of Hillsboro through a new booster station at the Beaverton Meter and near Highway 26. The remaining needed capacity for the City of Hillsboro would be supplied through existing storage in Hagg Lake and Barney Reservoir via the existing JWC WTP.

The existing Willamette River Water Treatment Plant is currently owned by the City of Wilsonville, Tualatin Valley Water District (TVWD) and the City of Sherwood. The original agreement creating the partnership between TVWD and the City of Wilsonville allows for TVWD to convey its ownership interest to the Willamette River Water Coalition (WRWC), formerly known as the Willamette Water Supply Agency. The WRWC maintains a 130 MDG water right for use by the WRWC members. Under the terms of the WRWC agreement, WRWC partners may individually propose expansion projects. Other WRWC partners are given an opportunity to participate in funding the proposed expansion; however, approval by all partners is not required. If other partners elect to not participate in funding, the expansion project may proceed as proposed by the funding partner(s). As an existing partner of the WRWC, TVWD (subject to approval by the TVWD Board) may propose expansion of the WRWTP that could be used to serve TVWD, Hillsboro and/or other JWC partners. TVWD has also suggested that

Hillsboro propose to become a member of the WRWC. If Hillsboro's membership is approved by the WRWC Board, Hillsboro could propose projects to increase treatment capacity at the existing plant per the WRWC agreement.

Options 2 includes the following components and are shown in **Figure 8-2B**:

- Replacement of existing in-river tee screens with two new larger-diameter screens connected to the existing raw water intake pipeline.
- The existing raw water intake pipeline and raw water pump station structure have sufficient capacity to handle the additional 80 mgd of flow; therefore, improvements to these facilities are not needed.
- Raw water pumps, raw water supply pipelines to the proposed water treatment plant, the proposed water treatment plant on the existing upper plant site, and finished water transmission pipeline capacities will be constructed to deliver 80 mgd. Of this total, 36 mgd would be supplied to the City of Hillsboro with the remaining 44 mgd being supplied to other project partners. Hillsboro's remaining supply needs would be supplied through existing storage in Hagg Lake/Barney Reservoir and treated at the existing JWC WTP. It is recommended that should this option be selected for further evaluation, the participants discuss the merits of sizing the transmission pipeline for flows beyond year 2050 during detailed design.
- Raw and finished water conveyance pipelines:
  - Mortar lined and coated welded steel.
  - 48-inch to 66-inch in diameter. Total pipeline length is approximately 137,500 feet (26.0 miles).
  - In-line butterfly valves with small bypass relief/drain valves, air relief/air inlet valves, and drain valves.
  - Preliminary location is within existing public rights-of-way.
- A water treatment plant with similar process technology to that of the existing Wilsonville WTP (ballasted sedimentation, ozone, granular media filtration using activated carbon and sand, and post-disinfection using chlorine) will be constructed on the site of the existing water treatment plant at Wilsonville and above the 100-year flood plain. The WTP size is approximately 10 acres, per the *2006 Willamette River WTP Master Plan Report*, MWH
- Cooper Mountain Terminal Reservoir: 20 MG
- Distribution booster pump station located at Hazeldale between the Cooper Mountain Terminal Reservoir and the JWC system.

3.3 Option 3 - Portland Supply Option

A new shared Washington County Supply Line (WCSL) would be constructed parallel to the existing WCSL from Powell Butte Reservoir to the TVWD and City of Hillsboro distribution systems to convey an additional 38 mgd of water from the PWB. TVWD's capacity share of the existing WCSL is 42 mgd (total capacity is about 60 mgd with capacity shares also held by Portland and City of Tualatin). The total capacity of the existing and new WCSL's would be 80 mgd. Of this total, 36 mgd would be supplied to the City of Hillsboro and be treated in a new water treatment plant while the remaining 44 mgd will be supplied to other project partners. Hillsboro's remaining supply needs would be supplied through existing storage in Hagg Lake/Barney Reservoir and treated at the existing JWC WTP.

Chloramine removal and filtration would likely be required for any supply delivered to the City of Hillsboro to meet its customer's water quality requirements. The new 36 mgd treatment plant would remove chloramines, filter the water to remove turbidity, and would inject chlorine using break-point chlorination. Split-stream reverse osmosis might be required to reduce dissolved solids and hardness as the system switches between the Bull Run Supply and the Columbia River Wellfield supply to be compatible with the needs of the City of Hillsboro customers. Chloramine removal and filtration of the portion delivered by the PWB to the City of Hillsboro was not included in the prior Carollo/MSA evaluation. The treatment plant is not rated at capacities above the Hillsboro demand, since TVWD customers already receive unfiltered and chloraminated water from the PWB system.

The availability of water from the PWB has not been evaluated and may not be available in the quantity needed. Regardless, a long-term wholesale water supply contract would need to be negotiated between the PWB and the parties involved in the water supply project. Negotiations and coordination with the PWB were not conducted as part of this project. For planning purposes, it was assumed the rates and structure of any contract would be similar in nature to TVWD's existing contract with the PWB.

This option also includes a new 20 million gallon covered concrete reservoir shown at Cooper Mountain. If this option is selected, it is recommended that an alternative alignments be reviewed

Options 3 includes the following components and are shown in **Figure 8-2C**:

- New transmission pipeline capacity (paralleling the existing transmission pipeline) will be 38 mgd. Of this total, 36 mgd would be supplied to the City of Hillsboro with the remaining needed capacity for the City of Hillsboro would be supplied through existing storage in Hagg Lake and the existing JWC WTP. It is recommended that should this option be selected for further evaluation, the participants discuss the merits of sizing the transmission pipeline for flows beyond year 2050 during detailed design.
- Finished water conveyance pipelines:
    - Mortar lined and coated welded steel.
    - 48-inch to 60-inch diameter. Total pipeline length is approximately 227,300 feet long (43.0 miles)

  - In-line butterfly valves with small bypass relief/drain valves, air relief/air inlet valves, and drain valves.
  - Preliminary location is within existing public rights-of-way.
- A water treatment plant with similar process technology to that of the existing Wilsonville WTP (ballasted sedimentation, ozone, granular media filtration using activated carbon and sand, and post-disinfection using chlorine) with split treatment reverse osmosis to make the water equivalent to the JWC WTP. The new WTP will be constructed on a site (approximately 40 acres) located above the 100-year flood plain near Hillsboro.
- Cooper Mountain Terminal Reservoir: 20 MG. This reservoir was included for equivalent comparison with the other options. The alignment shows one pipeline going into and a separate pipeline going out of the reservoir along the west and south of Cooper Mountain. It is recommended that alternative alignments be evaluated during design.
- Distribution booster pump station located between Hazeldale and Highway 26 Hillsboro turnout.
- A smaller dam raise project to provide water for Clean Water Services. This smaller dam raise would raise the water surface by 12.5 feet if the dam is reconstructed at its current location or 7.5 feet if a new dam was constructed downstream
- Participation as part of the Local Contribution (expected to remain at 15% of the cost) to improve the seismic robustness of the existing Scoggins Dam.

3.4 Options 4 and 5: Willamette-Newberg Supply (West and East Sub-Options)

Surface water from the Willamette River would be treated in a new plant near Newberg and pumped through a new transmission system along a western alignment (Option 4, West Sub-Option) or an eastern alignment (Option 5, East Sub-Option) to the existing Hillsboro/JWC supply system. These options have been evaluated at a limited conceptual level of design.

Options 4 and 5 each include the following components and are shown in **Figure 8-2D**:

- The intake, water treatment plant, and transmission pipeline capacity will be 80 mgd. Of this total, 36 mgd would be supplied to the City of Hillsboro, with the remaining 44 mgd being supplied to other project partners. Hillsboro's remaining supply needs would be supplied through existing storage in Hagg Lake/Barney Reservoir and treated at the existing JWC WTP. It is recommended that should this option be selected for further evaluation, the participants discuss the merits of sizing the transmission pipeline for flows beyond 2050 during detailed design.
- The intake is assumed to be a tee-type wedge-wire slotted screen projecting from the bed of the Willamette River. The intake screen would be connected through a bored pipe connection with an on-bank caisson.
- On-bank intake caisson includes a raw water pump station discharging at the new WTP.

- Raw and finished water conveyance pipelines:
  - Mortar lined and coated welded steel.
  - 66-inch, 60-inch, and 48-inch diameter.
  - In-line butterfly valves with small bypass relief/drain valves, air relief/air inlet valves, and drain valves.
  - Preliminary location is within existing public rights-of-way.
- A conventional water treatment plant (approximately 40 acres) with ozone will be located above the 100-year flood plain near Newberg. The water treatment plant would use treatment processes similar to those used at the Willamette River Water Treatment Plant.
- Two alternative raw and finished water transmission pipeline alignments due to the varying topography encountered between the City of Newberg and the City of Hillsboro:
  - West alignment (Option 4, West Sub-Option):
    - Raw and finished water conveyance pipelines terminating at or near the JWC Water Treatment plant: 111,300 feet (21.1 miles).
    - Booster pump station at or near the JWC Water Treatment Plant with a 5,800 feet (1.1 mile) conveyance pipeline discharging at the Fern Hill Reservoirs.
    - Finished water distribution (48 and 60-inch diameter) pipelines: 93,600 feet (17.7 miles).
    - Total pipeline length: 210,700 ft (39.9 miles)
    - Terminal Reservoir: 20 MG located at Fern Hill
  - East alignment (Option 5, East Sub-Option):
    - Raw and finished water conveyance pipelines terminating at the proposed Cooper Mountain Terminal Reservoir: 92,900 feet (17.6 miles).
    - Booster pump station along Roy Rogers Road north of the Tualatin River and Beef Bend Road.
    - Finished water distribution (60-inch and 48-inch diameter) pipelines: 65,700 feet (12.4 miles).
    - Distribution booster pump station located at Hazeldale between the Cooper Mountain Terminal Reservoir and the JWC system.
    - Total pipeline length: 158,600 ft (30.0 miles)
    - Terminal Reservoir: 20 MG located at Cooper Mountain
- A smaller dam raise project to provide water for Clean Water Services. This smaller dam raise would raise the water surface by 12.5 feet if the dam is reconstructed at its current location or 7.5 feet if a new dam was constructed downstream

- Participation as part of the Local Contribution (expected to remain at 15% of the cost) to improve the seismic robustness of the existing Scoggins Dam.

3.5 Option 6 - Northern Groundwater Supply Option

This option proposes to obtain 80 mgd of groundwater production from new collector wells constructed east of Scappoose. The supply would be treated in a new water treatment plant near Scappoose and pumped through a new pipeline over Cornelius Pass to Hillsboro. Of this total, 36 mgd would be supplied to the City of Hillsboro with the remaining 44 mgd being supplied to other project partners. Hillsboro's remaining supply needs would be supplied through existing storage in Hagg Lake/Barney Reservoir and treated at the existing JWC WTP.. This option has been evaluated at a conceptual level by CH2M Hill. It was evaluated to a higher level of detail compared to the Willamette-Newberg Supply Options in accordance with project scope requirements and is described in detail in a separate design report included in **Appendix C** of this TM.

Options 6 includes the following components and are shown in **Figure 8-2E**:

- 80 mgd wellfield – Based on analysis completed by GSI Water Solutions, Inc., it is possible that a wellfield capable of delivering 80 mgd could be constructed on the west bank of Multnomah Channel east of Scappoose. For planning purposes, it is assumed that a total of eight radial collector wells would be constructed. Additional water rights investigations and test pumping will be needed to estimate possible yields, determine possible impacts on existing water rights holders and environmental uses of water, verify that the well sites would not be adversely affected by environmental contamination, and develop design criteria for the wells. Each well would have a capacity of 10 mgd and would consist of a reinforced concrete caisson with a diameter of 20 feet completed at a depth of approximately 150 feet below the surface. Radial collectors would draw water from the aquifer into the well. Each well would be equipped with vertical turbine pumps with submersible motors, electrical control equipment, and a standby generator. It is assumed that the local electrical power provider (Columbia River PUD) will provide power at each well site and that each well will be individually metered. The caisson would be completed above the 100-year flood elevation of 33 feet in Multnomah Channel. Site improvements would include a gravel access road, fencing, gates, and landscaping.
- 80 mgd water treatment plant – The treatment plant would produce water similar to the quality delivered by the JWC system. It is assumed the water from the wells would be classified as groundwater under the influence of surface water, requiring treatment to remove microbiological contaminants. The groundwater may also contain iron, manganese, and dissolved solids at concentrations exceeding customer acceptance limits. It is also assumed the ground water will require pH adjustment to control corrosion of customer piping. The treatment processes needed to produce water similar to that delivered by JWC include oxidation of iron and manganese, dual media filtration, split stream treatment using reverse osmosis to remove dissolved solids, addition of a small amount of sodium hydroxide for corrosion control, and disinfection using chlorine. The

water treatment plant could be sited anywhere along the pipeline route from the wellfield to Hillsboro. For planning purposes, it is assumed that the plant will be constructed near the wellfield in Scappoose. The plant would also include a 20 MG clearwell and a booster pumping station pumping to the McCarthy Creek Booster Pumping Station. The treatment equipment would be housed in buildings. It is assumed that emergency power generators will be needed. Backwash water would be decanted in storage lagoons. The decant would be recycled through the water treatment plant. Based on information from other construction projects in the Scappoose area, it is assumed that foundation conditions are poor at the water treatment plant site and overexcavation and imported backfill would be required under all structures.

- 80 mgd McCarthy Creek Booster Pumping Station – A booster pumping station would be constructed near McCarthy Creek to limit operating pressures in the pipeline system to 120 psi. The pumping station would consist of lineshaft-driven vertical turbine pumps drawing from a 3.4 MG forebay. An emergency generator would be provided. The forebay, pumps, generators, and electrical controls would be enclosed in a concrete block building. It is assumed that the local power provider (Portland General Electric) can provide power to the site. Site improvements would include a drive, fencing, gates, and landscaping.
- 20 MG treated water storage reservoir – A 20 MG treated water storage reservoir would be provided between Cornelius Pass and Hillsboro. The reservoir would be an above grade circular prestressed tank. The location of the terminal reservoir is yet to be determined, but is graphically shown in the figure.
- Pipelines – Total pipeline length of 135,700 (25.7 miles). Approximately 115,000 feet (21.8 miles) of pipelines with diameters from 24 inches to 66 inches would be constructed to convey water from the wellfield to the water treatment plant and then to Hillsboro, connecting the JWC system on the south side of the intersection of Highway 26 and Cornelius Pass Road. Approximately 20,700 ft (3.9 miles) of pipeline continues south along Cornelius Pass Road to connect the North and South transmission pipelines. This pipeline connects both dead-ends adding redundancy to the system in case one transmission pipeline is out of service. A reconnaissance-level investigation was undertaken to locate and evaluate possible pipeline routes. A feasible corridor paralleling Highway 30 from Scappoose to Cornelius Pass Road and then paralleling Cornelius Pass Road from Highway 230 to Highway 26 was identified. It is recommended that should this option be selected for further evaluation, the participants discuss the merits of sizing the transmission pipeline for flows beyond year 2050 during detailed design.
- A smaller dam raise project to provide water for Clean Water Services. This smaller dam raise would raise the water surface by 12.5 feet if the dam is reconstructed at its current location or 7.5 feet if a new dam was constructed downstream
- Participation as part of the Local Contribution (expected to remain at 15% of the cost) to improve the seismic robustness of the existing Scoggins Dam.

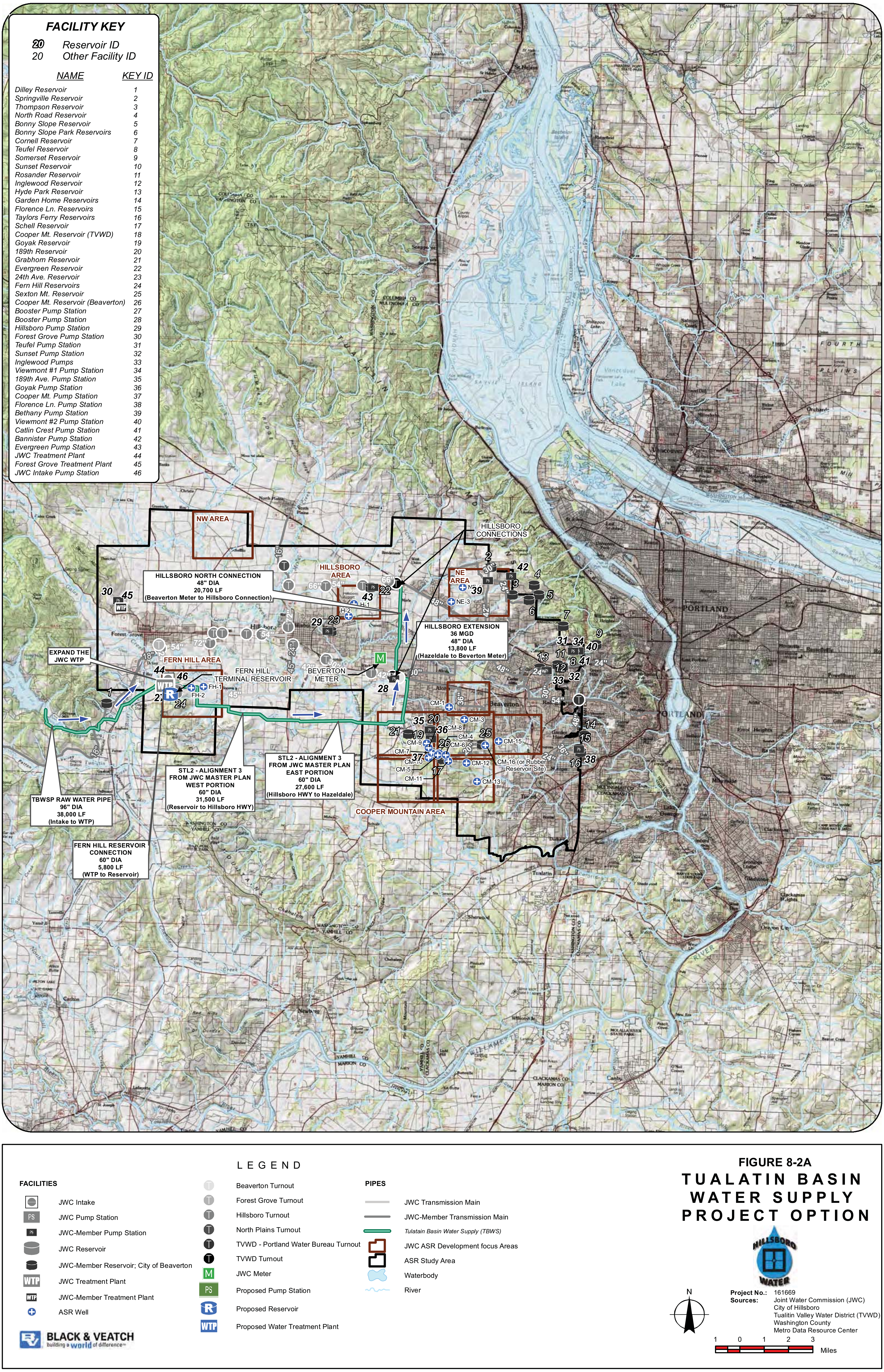
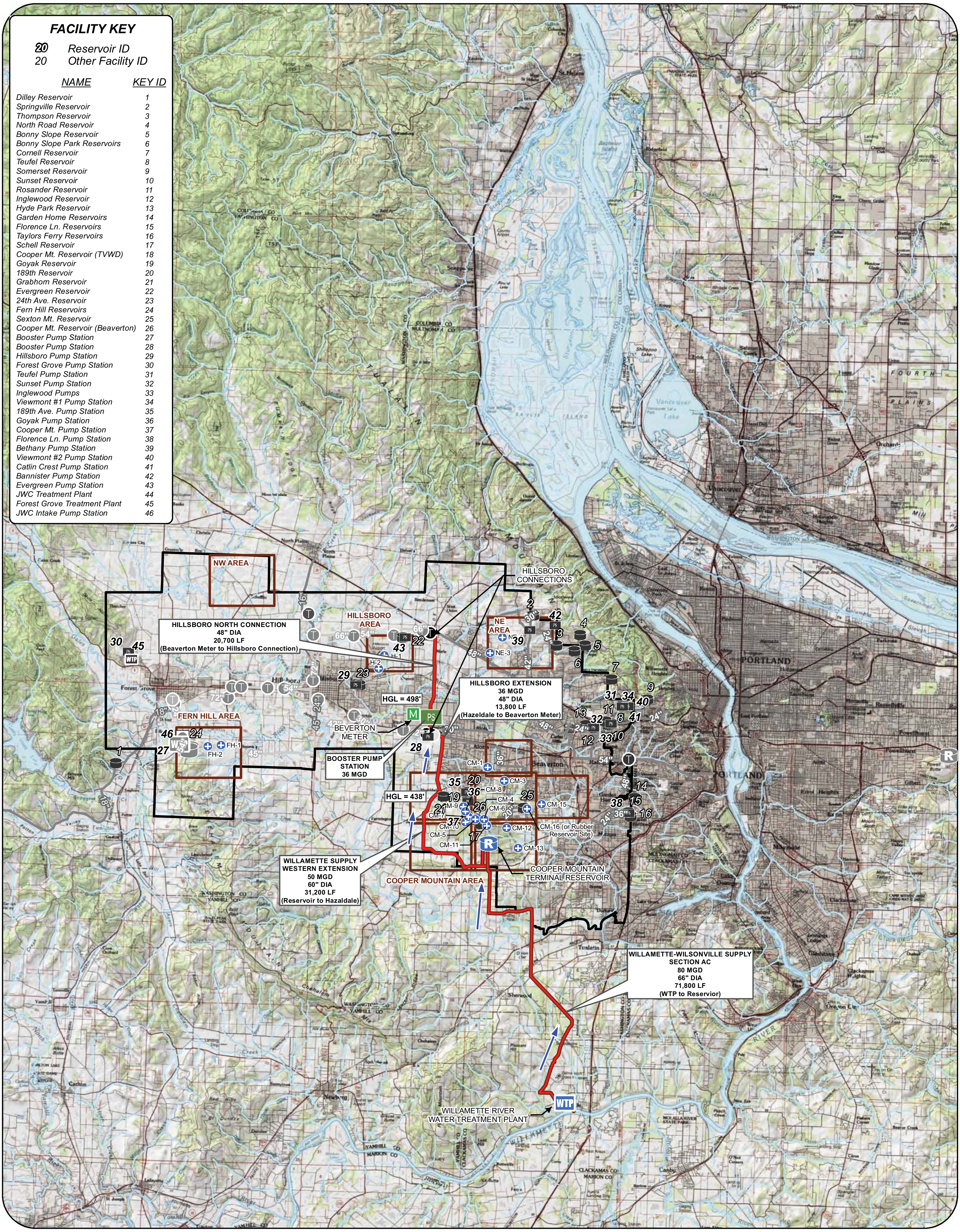


FIGURE 8-2A
TUALATIN BASIN WATER SUPPLY PROJECT OPTION



LEGEND

FACILITIES

- JWC Intake
- JWC Pump Station
- JWC-Member Pump Station
- JWC Reservoir
- JWC-Member Reservoir; City of Beaverton
- JWC Treatment Plant
- JWC-Member Treatment Plant
- ASR Well

- Beaverton Turnout
- Forest Grove Turnout
- Hillsboro Turnout
- North Plains Turnout
- TVWD - Portland Water Bureau Turnout
- TVWD Turnout
- JWC Meter
- Proposed Pump Station
- Proposed Reservoir
- Proposed Water Treatment Plant

PIPES

- JWC Transmission Main
- JWC-Member Transmission Main
- Willamette - Wilsonville Supply Option
- JWC ASR Development focus Areas
- ASR Study Area
- Waterbody
- River

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FIGURE 8-2B
WILLAMETTE - WILSONVILLE OPTION

HILLSBORO WATER

N

Project No.: 161669
Sources: Joint Water Commission (JWC)
City of Hillsboro
Tualatin Valley Water District (TVWD)
Washington County
Metro Data Resource Center

1 0 1 2 3
Miles

December 5, 2011

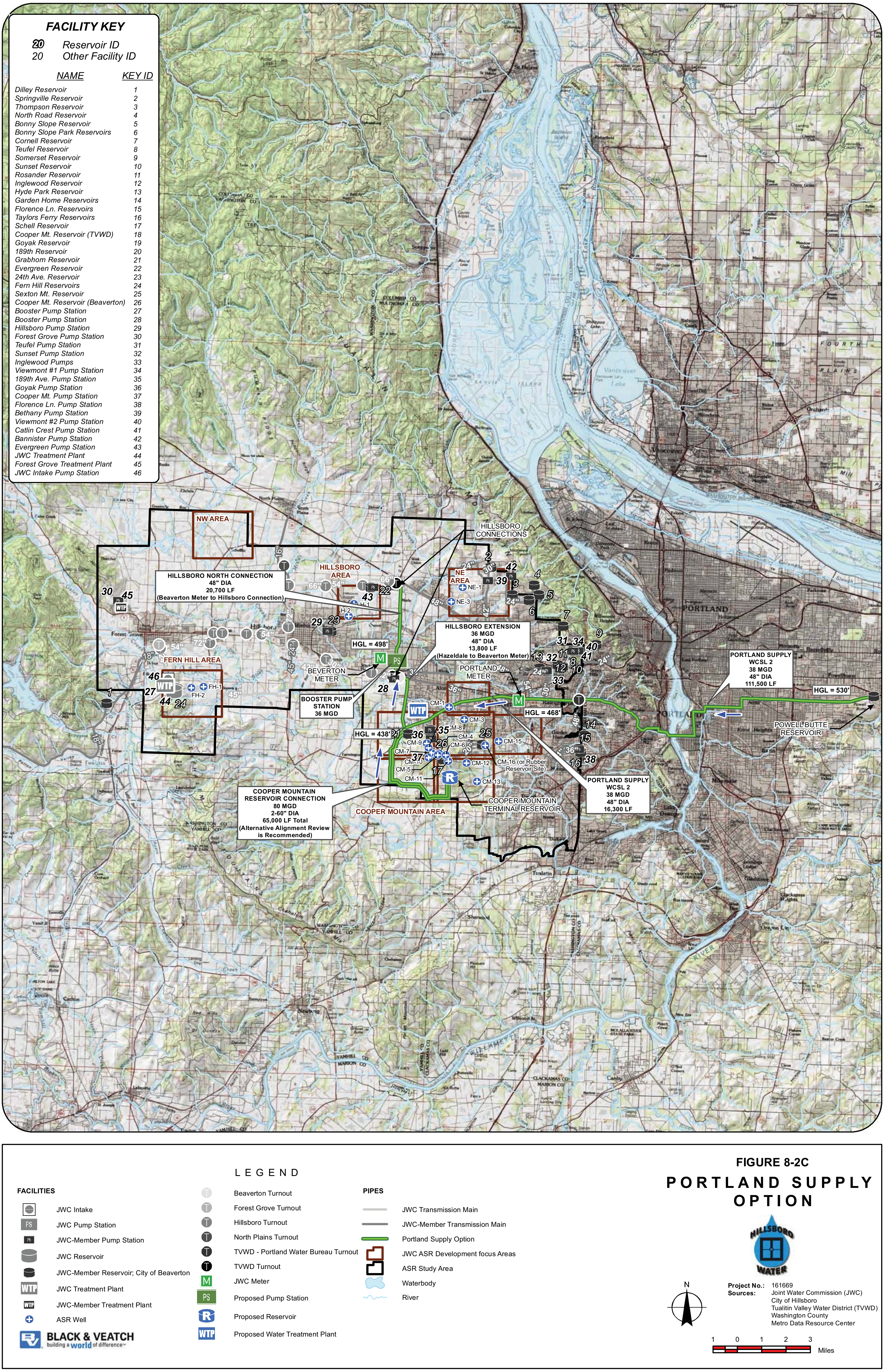

FIGURE 8-2C
PORTLAND SUPPLY OPTION

LEGEND

FACILITIES

- JWC Intake
- JWC Pump Station
- JWC-Member Pump Station
- JWC Reservoir
- JWC-Member Reservoir
- JWC Treatment Plant
- JWC-Member Treatment Plant
- JWC-Meter
- Proposed WTP
- Proposed Terminal Reservoir
- Proposed Pumping Station
- Proposed Intake
- Beaverton Turnout
- Forest Grove Turnout
- Hillsboro Turnout
- North Plains Turnout
- TVWD - Portland Water Bureau Turnout
- TVWD Turnout
- Divide Between Tualatin River Basin and Willamette River Basin

PIPES

- JWC Transmission Main
- JWC-Member Transmission Main

SUPPLY OPTIONS

- Proposed West Sub-Option
- Proposed East Sub-Option

BASEMAP

- Freeway
- Major Arterial
- Waterbody
- River

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FIGURE 8-2D

Willamette - Newberg Supply Options

HILLSBORO WATER

Project No.: 161669

Sources: Joint Water Commission (JWC), City of Hillsboro, Tualatin Valley Water District (TVWD), Washington County, Metro Data Resource Center

N

0.5 0 0.5 1 1.5 Miles

1 inch = 1.5 miles

\\na\data\Corp\Water\GIS\Departments\DEPT-3269\161661_Hillsboro_OR_Water_MasterPlan\11GIS\01ProjectFiles\AmendmentTM_Revision3\HA_Fig8-2D_Willamette-NewbergSupplyOptions(11X17).mxd

December 5, 2011

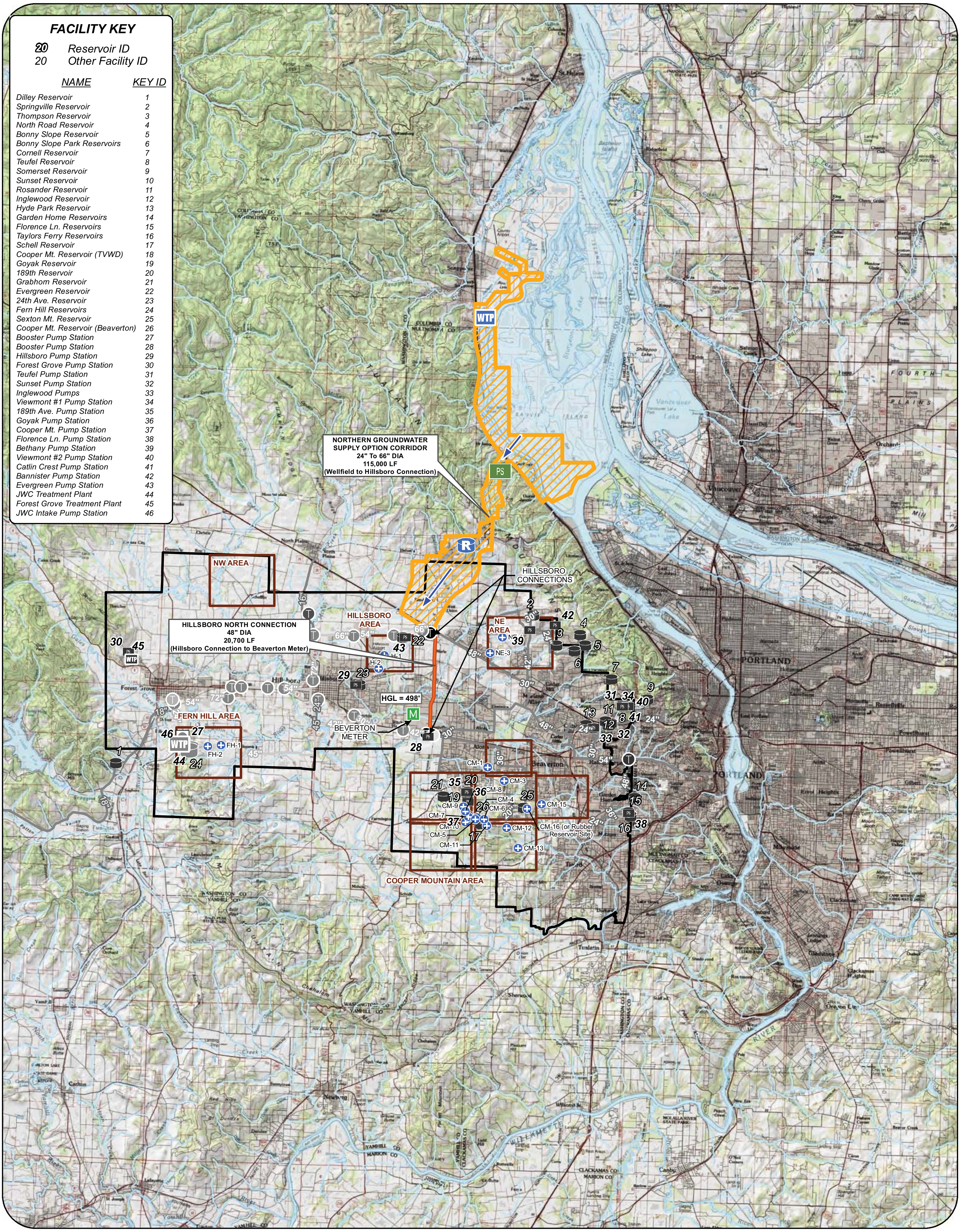

FIGURE 8-2E

NORTHERN GROUNDWATER SUPPLY OPTION

LEGEND

FACILITIES

- JWC Intake
- JWC Pump Station
- JWC-Member Pump Station
- JWC Reservoir
- JWC-Member Reservoir; City of Beaverton
- JWC Treatment Plant
- JWC-Member Treatment Plant
- ASR Well
- Beaverton Turnout
- Forest Grove Turnout
- Hillsboro Turnout
- North Plains Turnout
- TVWD - Portland Water Bureau Turnout
- TVWD Turnout
- JWC Meter
- Proposed Pump Station
- Proposed Reservoir
- Proposed Water Treatment Plant

PIPES

- JWC Transmission Main
- JWC-Member Transmission Main
- Hillsboro North Connection
- Northern Groundwater Supply Option Corridor
- JWC ASR Development focus Areas
- ASR Study Area
- Waterbody
- River

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HILLSBORO WATER

Project No.: 161669
Sources: Joint Water Commission (JWC)
City of Hillsboro
Tualitin Valley Water District (TVWD)
Washington County
Metro Data Resource Center

1 0 1 2 3 Miles

December 5, 2011

4.0 SOURCES

The following is a list of reports, data, and information used for this TM:

- *JWC Master Plan*, Black &Veatch, 2009.
- *Conceptual Level Design Technical Memorandum,* Kleinfelder, October 2010.
- *Economic Evaluation of Water Supply Alternatives,* Carollo and Red Oak Consulting, February 2010.
- *WRWTP Master Plan Final Report*, MWH, December 2006.
- *Willamette River Water Supply System – Potential Transmission Main Alignment Coordination Evaluation*, MSA, January 2011.
- *TBWSP Intake and Pump Station Alternative Cost Estimate, Cost Estimate 8-23-2011_Modified Vee.xlsx,* September 2011.

5.0 IMPLEMENTATION SCHEDULE

An implementation schedule for each option selected for further review will be developed after review of the options and discussion of possible phasing alternatives.

6.0 CONCLUSION

Following City and TAC review of this Technical Memorandum, the further development of this project will proceed as follows:

- Cost generation in TM 09.
- Evaluate both qualitative and quantitative approaches to the evaluation of water supply options in TM 10.
- Recommendation to further design investigation of the top rated long-term water supply strategy for the City of Hillsboro.
- Publish final report for public review and input.

Cygnet\161661\ Water Supply Evaluation\ E Design Reports and Memoranda\E 1.0 Technical Memoranda \E 1.8 TM08 Development of Water Supply Options\TM08–Summary of Water Supply Development Options.doc

APPENDIX A

Conceptual Ground Profiles and Hydraulic Gradelines

RAW WATER PIPELINE

Joint Water Commission

Preliminary Design Report

Figure 3.2 JANUARY 2006

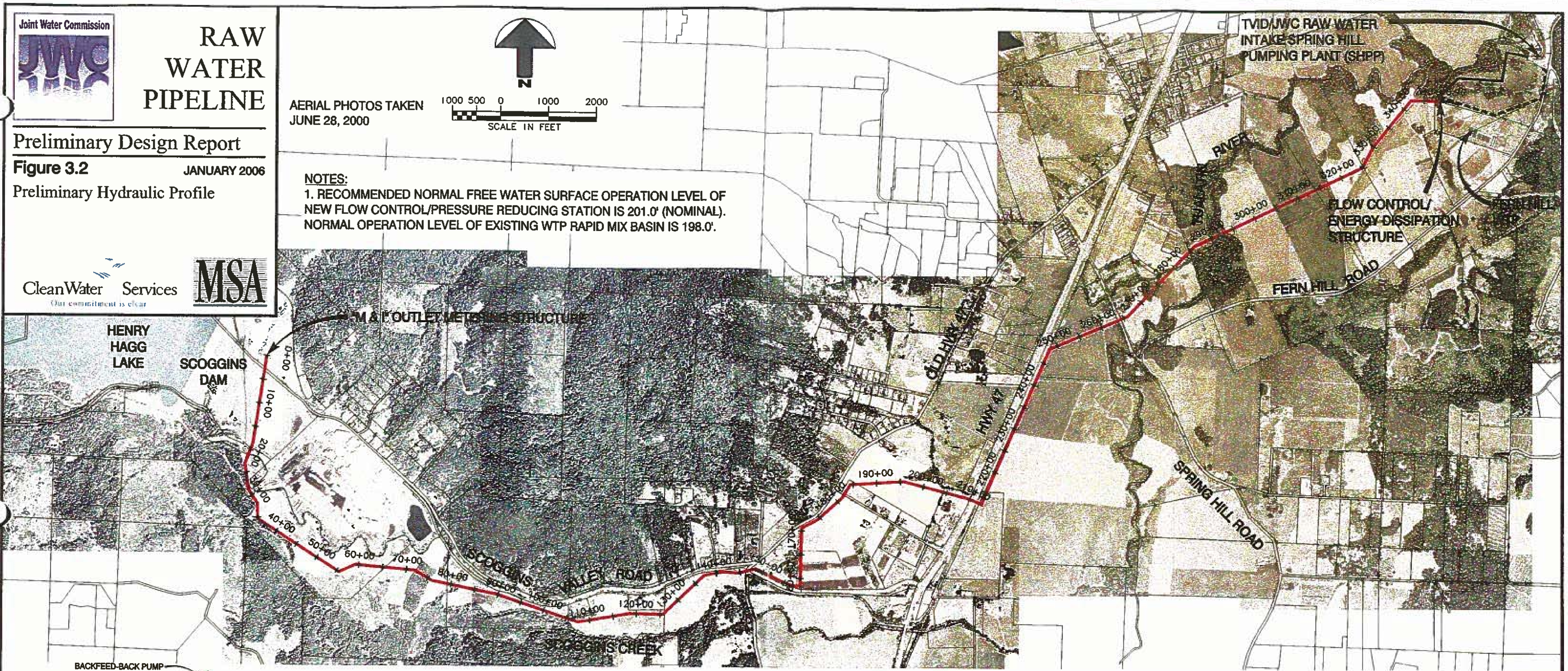
Preliminary Hydraulic Profile

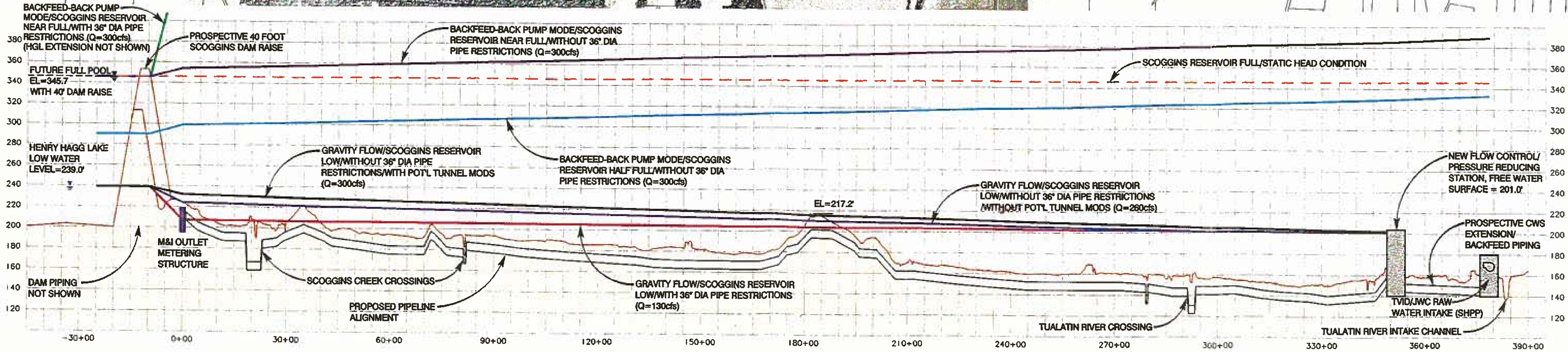
Clean Water Services
Our commitment is clear

MSA

AERIAL PHOTOS TAKEN
JUNE 28, 2000

NOTES:
1. RECOMMENDED NORMAL FREE WATER SURFACE OPERATION LEVEL OF NEW FLOW CONTROL/PRESSURE REDUCING STATION IS 201.0' (NOMINAL). NORMAL OPERATION LEVEL OF EXISTING WTP RAPID MIX BASIN IS 198.0'.

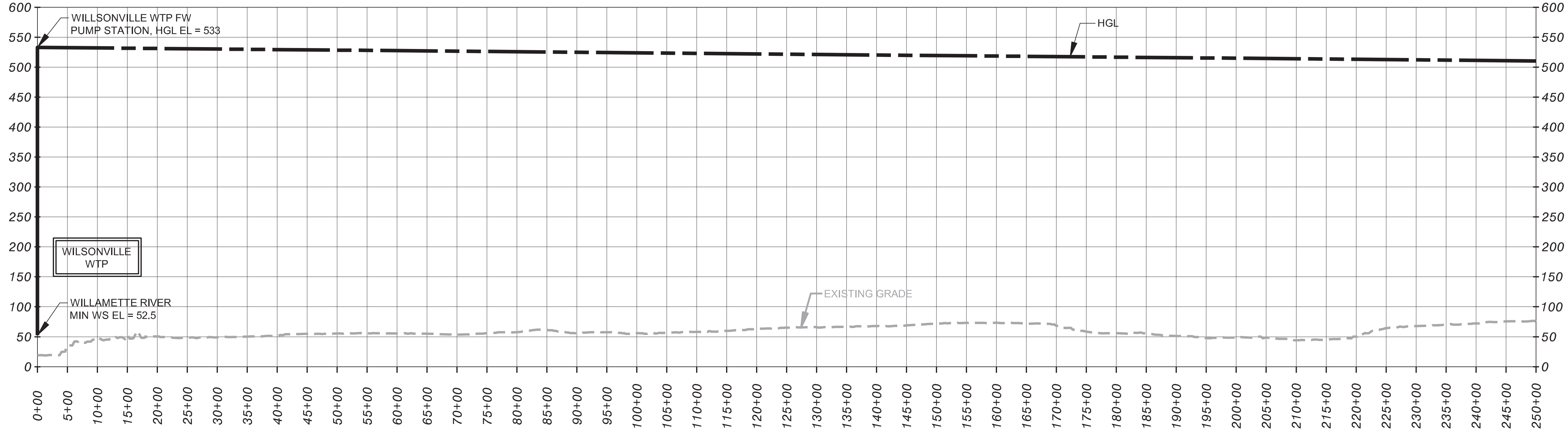




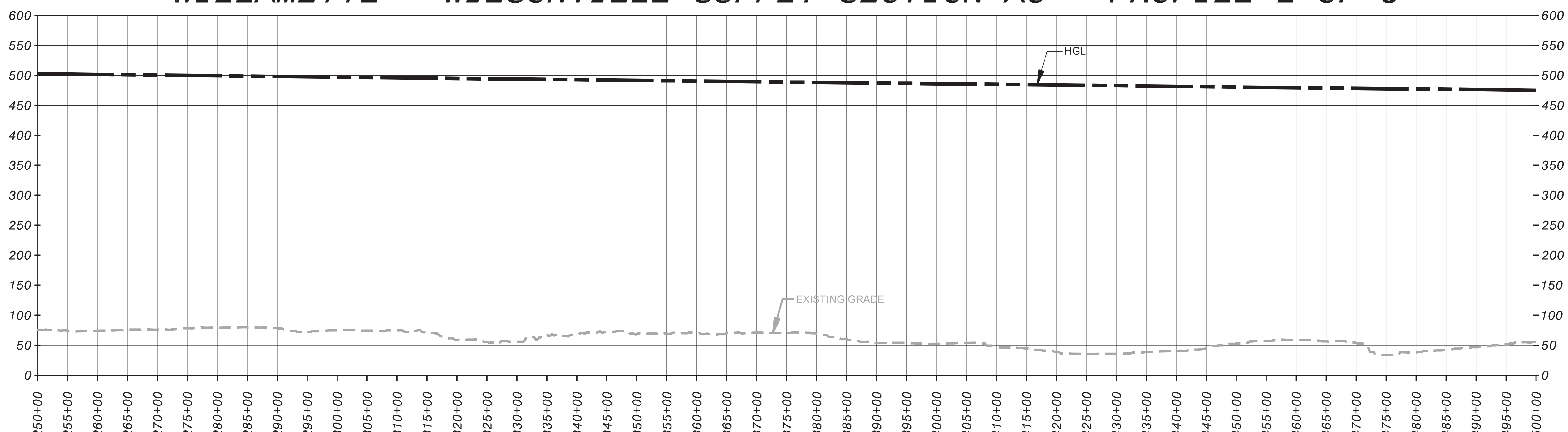
PRELIMINARY HYDRAULIC PROFILE
SCALE: 1"=3000' HORIZ, 1"=100' VERT

G:\04\0680\211\Figures\FINAL\04-0680-211-OR-FIG-3_2.dwg Figure 3.2 Oct/26/2005 08:

WILLAMETTE - WILSONVILLE SUPPLY SECTION AC - PROFILE 1 OF 3



WILLAMETTE - WILSONVILLE SUPPLY SECTION AC - PROFILE 2 OF 3



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1"=2000' HORIZONTAL SCALE

100' 50' 0 100' 200'
1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

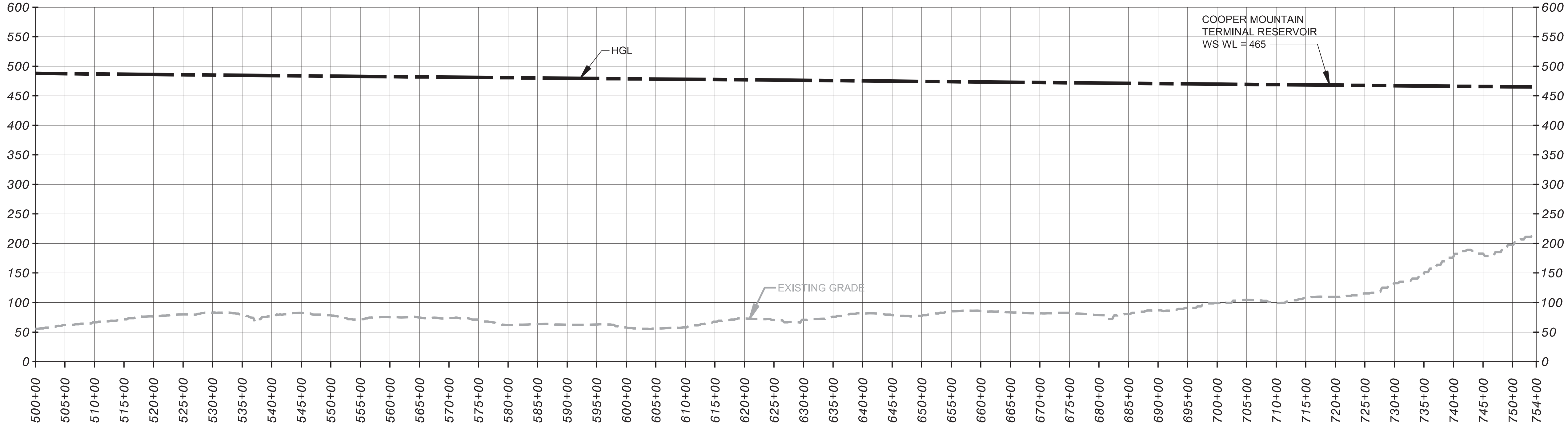
BLACK & VEATCH
Black & Veatch Corporation
Portland, Oregon

CITY OF OF HILLSBORO
WILLAMETTE - WILSONVILLE SUPPLY OPTION

TRANSMISSION PIPELINE - SECTION AC
PROFILE SHEET 1 OF 2

PROFILE
8-2.1

WILLAMETTE - WILSONVILLE SUPPLY SECTION AC - PROFILE 3 OF 3



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1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

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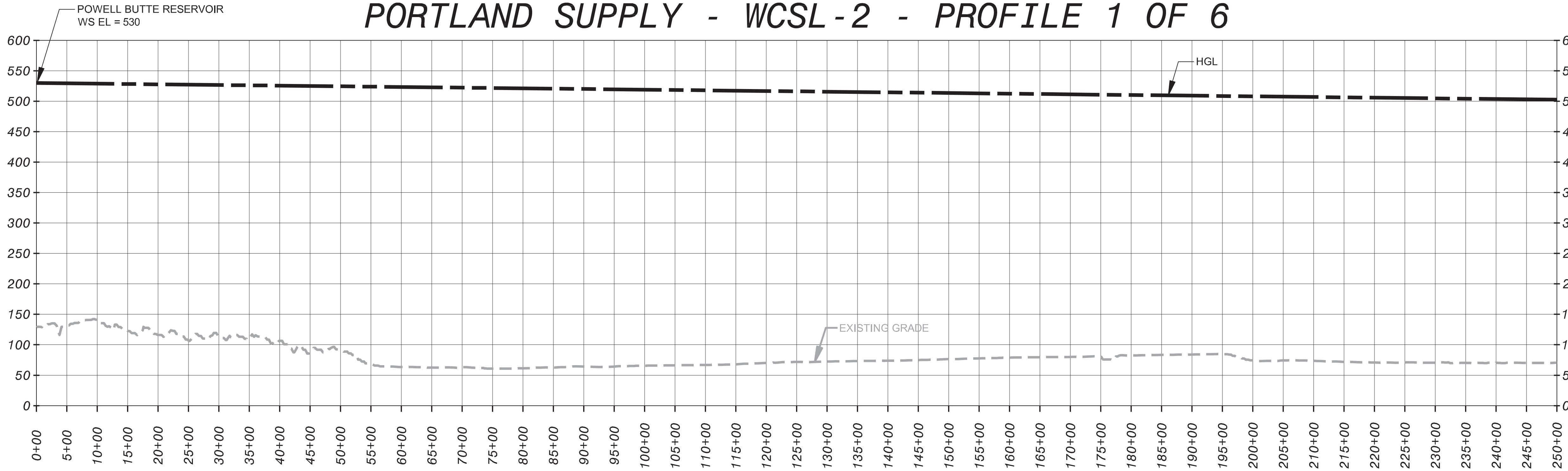
CITY OF OF HILLSBORO
WILLAMETTE - WILSONVILLE SUPPLY OPTION

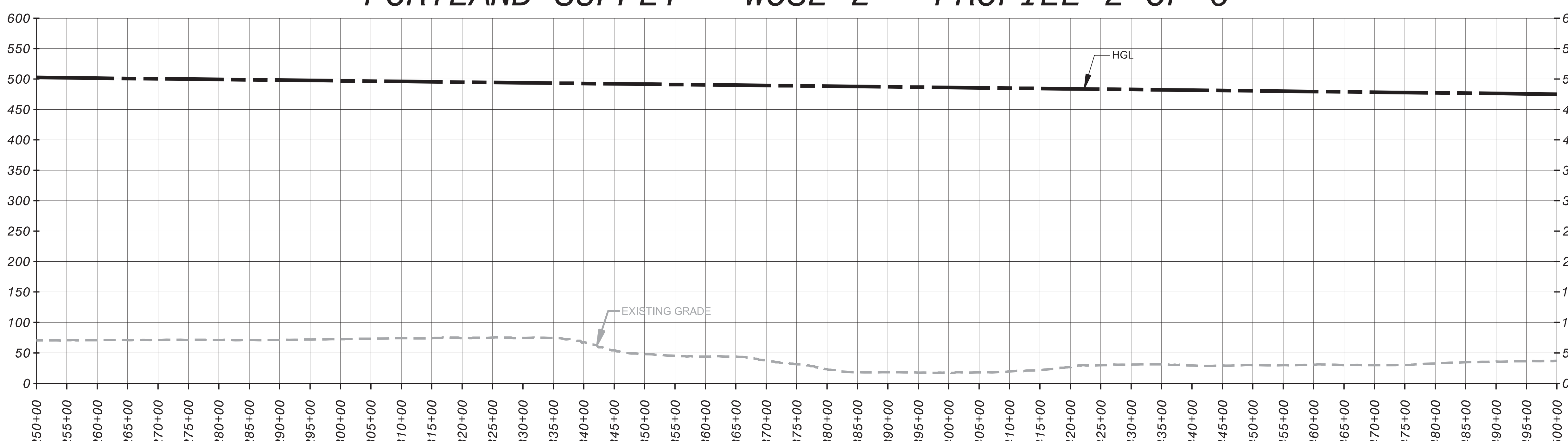
TRANSMISSION PIPELINE - SECTION AC
PROFILE SHEET 2 OF 2

PROFILE
8-2.2

PORTLAND SUPPLY - WCSL-2 - PROFILE 1 OF 6



PORTLAND SUPPLY - WCSL-2 - PROFILE 2 OF 6



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1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

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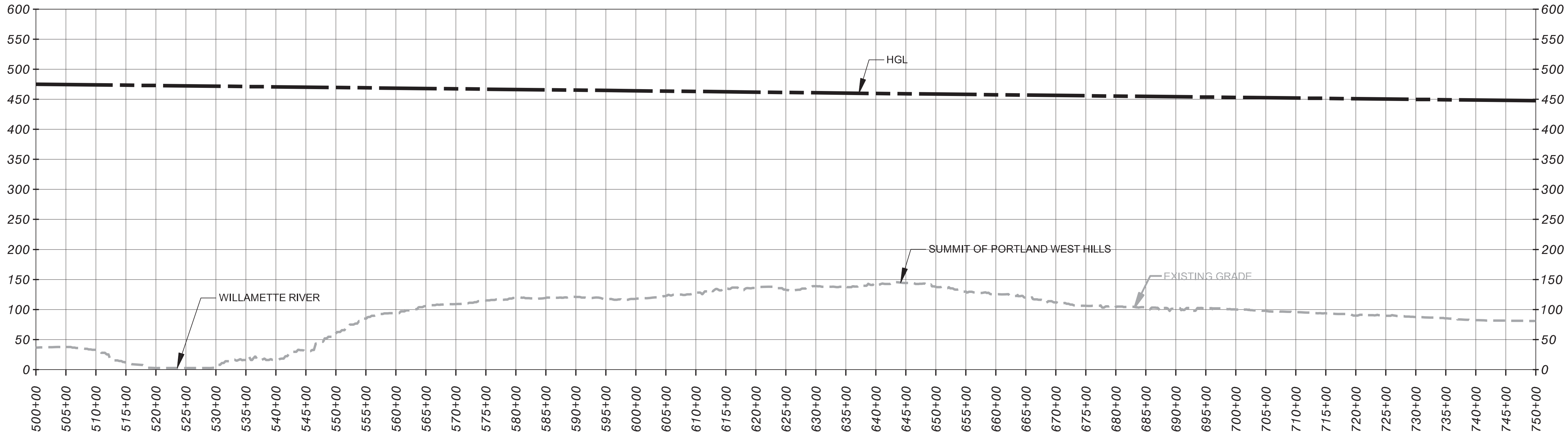
Portland, Oregon

CITY OF OF HILLSBORO
PORTLAND SUPPLY OPTION

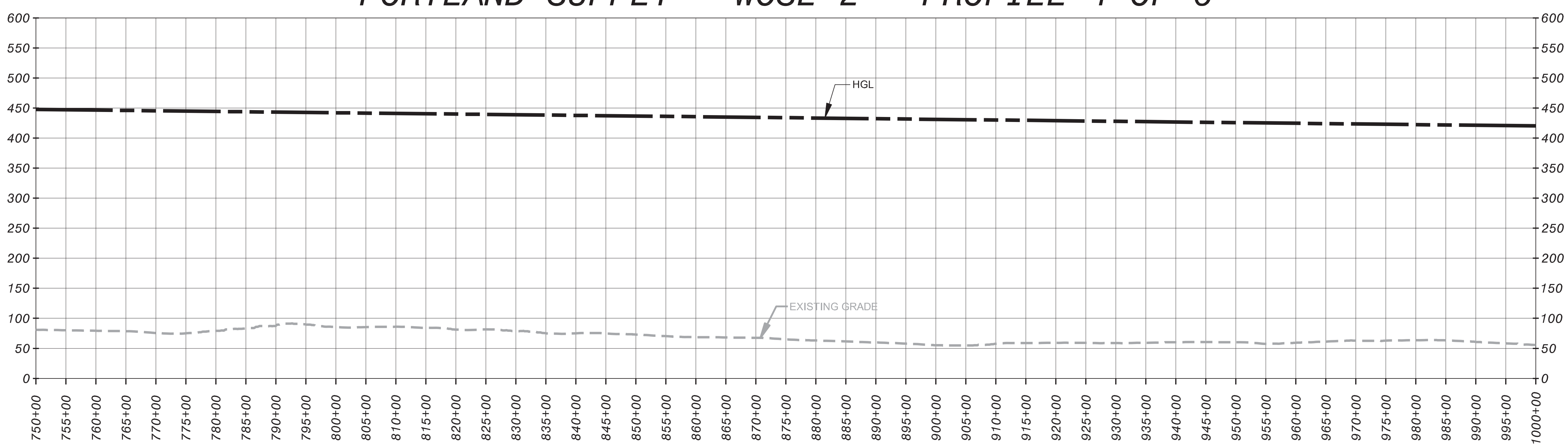
TRANSMISSION PIPELINE - WCSL 2
PROFILE SHEET 1 OF 3

PROFILE
8-3.1

PORTLAND SUPPLY - WCSL-2 - PROFILE 3 OF 6



PORTLAND SUPPLY - WCSL-2 - PROFILE 4 OF 6



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1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

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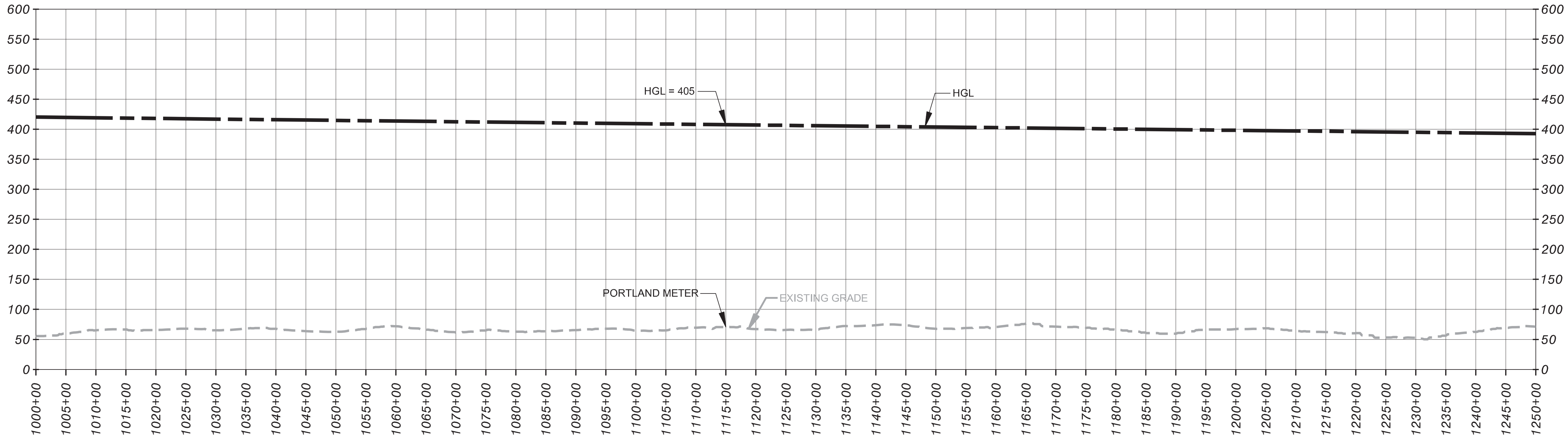
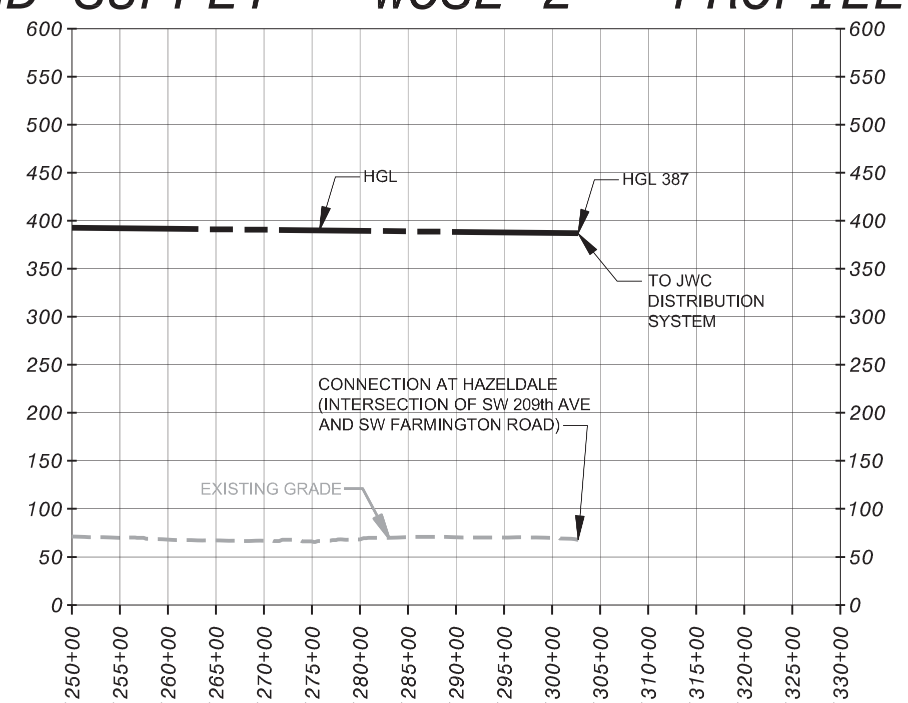
CITY OF OF HILLSBORO
PORTLAND SUPPLY OPTION
TRANSMISSION PIPELINE - WCSL 2
PROFILE SHEET 2 OF 3

PROFILE
8-3.2

PORTLAND SUPPLY - WCSL-2 - PROFILE 5 OF 6



PORTLAND SUPPLY - WCSL-2 - PROFILE 6 OF 6



NOTE:
THE TERMINAL RESERVOIR LOCATION HAS NOT BEEN DETERMINED FOR THIS OPTION. THEREFORE, THE RESERVOIR LOCATION IS NOT SHOWN.

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1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

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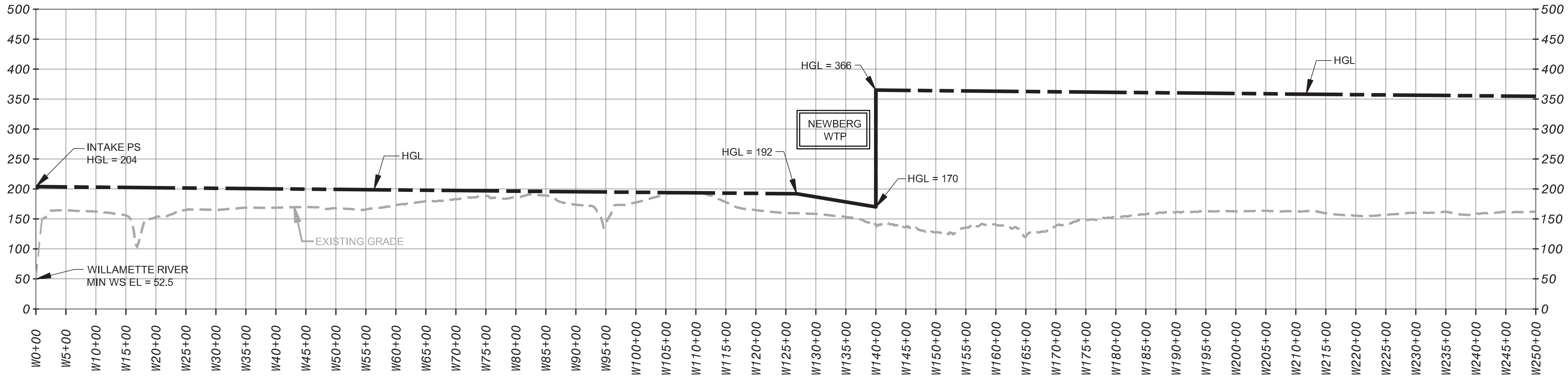
CITY OF OF HILLSBORO
PORTLAND SUPPLY OPTION

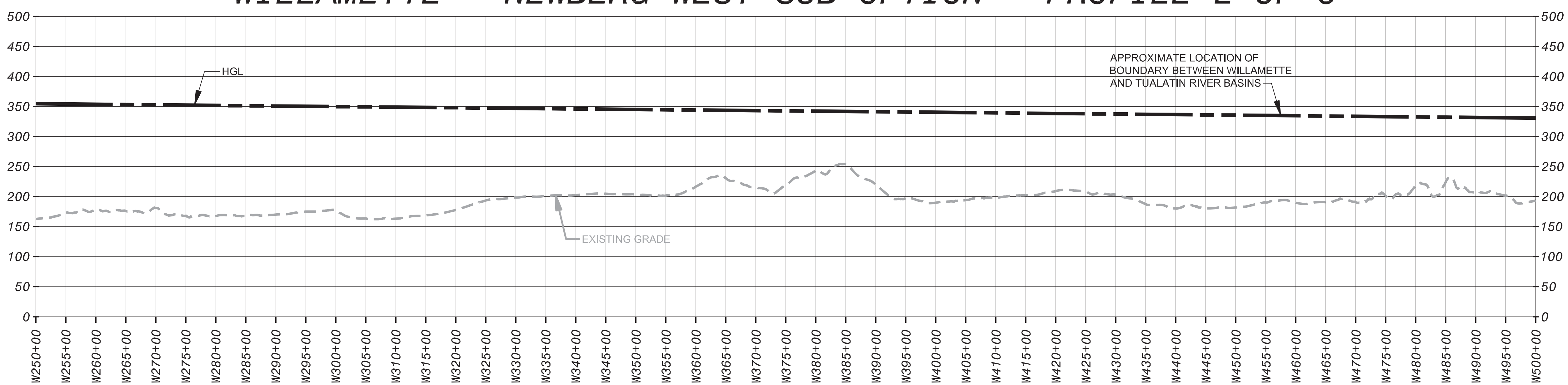
TRANSMISSION PIPELINE - WCSL 2
PROFILE SEET 3 OF 3

PROFILE
8-3.3

WILLAMETTE - NEWBERG WEST SUB-OPTION - PROFILE 1 OF 5



WILLAMETTE - NEWBERG WEST SUB-OPTION - PROFILE 2 OF 5



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1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

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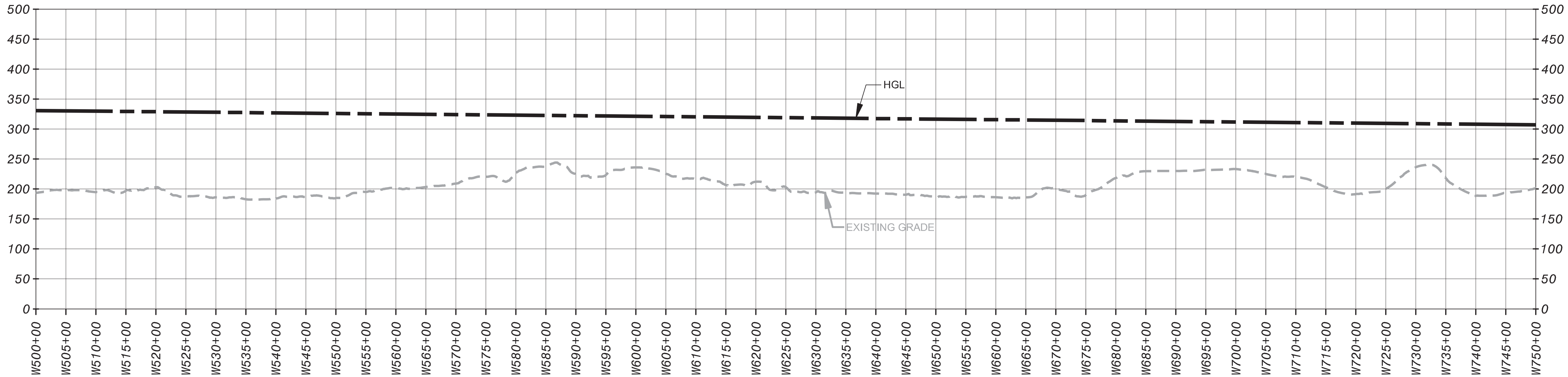
Portland, Oregon

CITY OF OF HILLSBORO
WILLAMETTE - NEWBERG SUPPLY OPTION

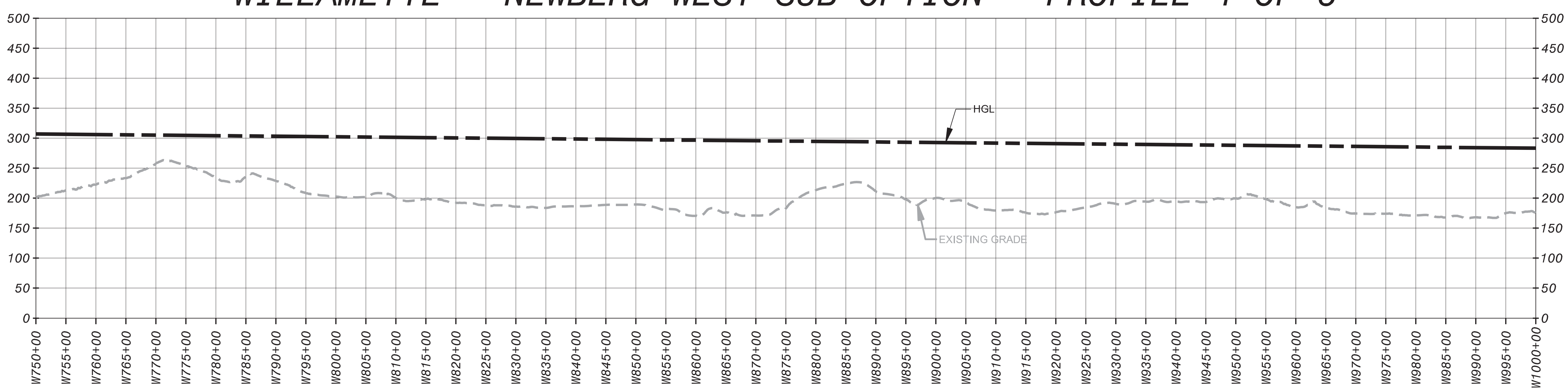
TRANSMISSION PIPELINE - WEST OPTION
PROFILE SHEET 1 OF 3

PROFILE
8-4.1

WILLAMETTE - NEWBERG WEST SUB-OPTION - PROFILE 3 OF 5



WILLAMETTE - NEWBERG WEST SUB-OPTION - PROFILE 4 OF 5



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1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

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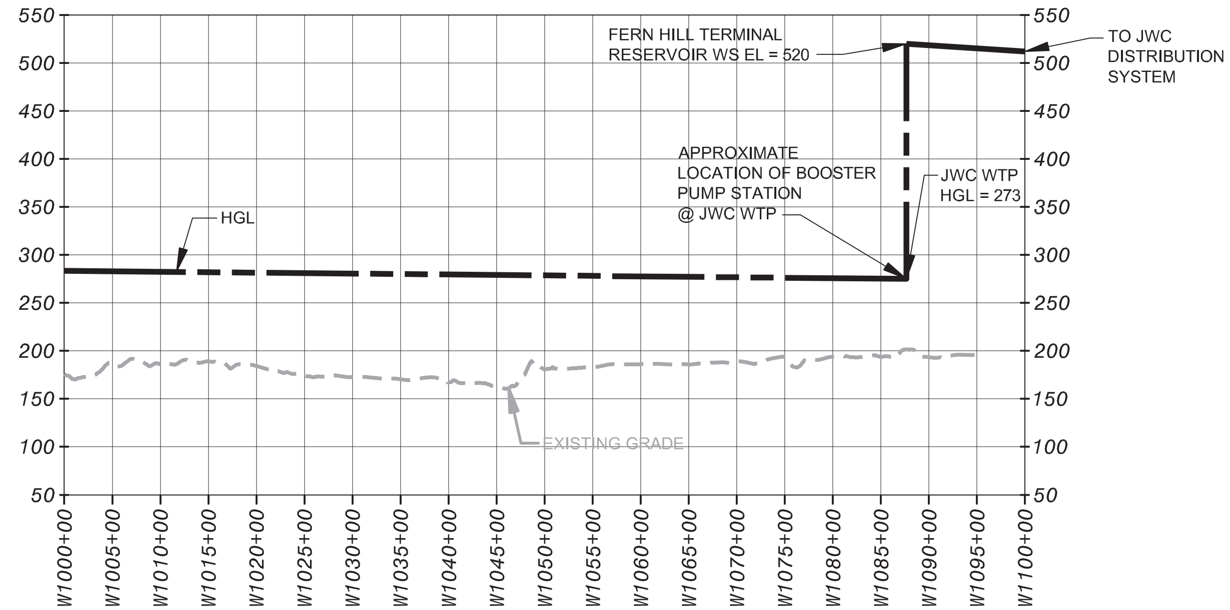
CITY OF OF HILLSBORO
WILLAMETTE - NEWBERG SUPPLY OPTION

TRANSMISSION PIPELINE - WEST OPTION
PROFILE SHEET 2 OF 3

PROFILE
8-4.2

WILLAMETTE - NEWBERG WEST SUB-OPTION - PROFILE 5 OF 5



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PRELIMINARY - NOT FOR CONSTRUCTION

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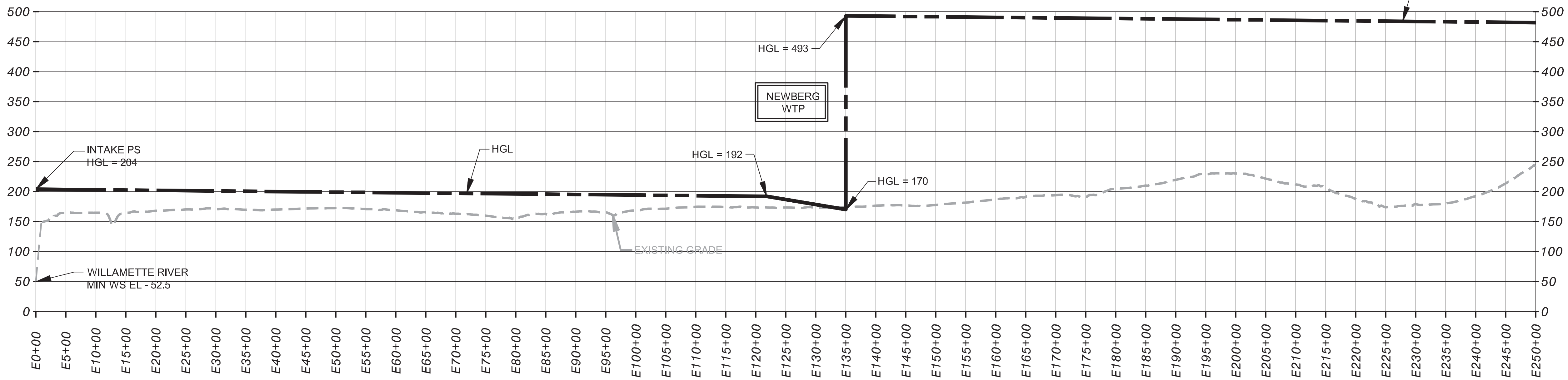
Portland, Oregon

CITY OF OF HILLSBORO
WILLAMETTE - NEWBERG SUPPLY OPTION

TRANSMISSION PIPELINE - WEST OPTION
PROFILE SHEET 3 OF 3

PROFILE
8-4.3

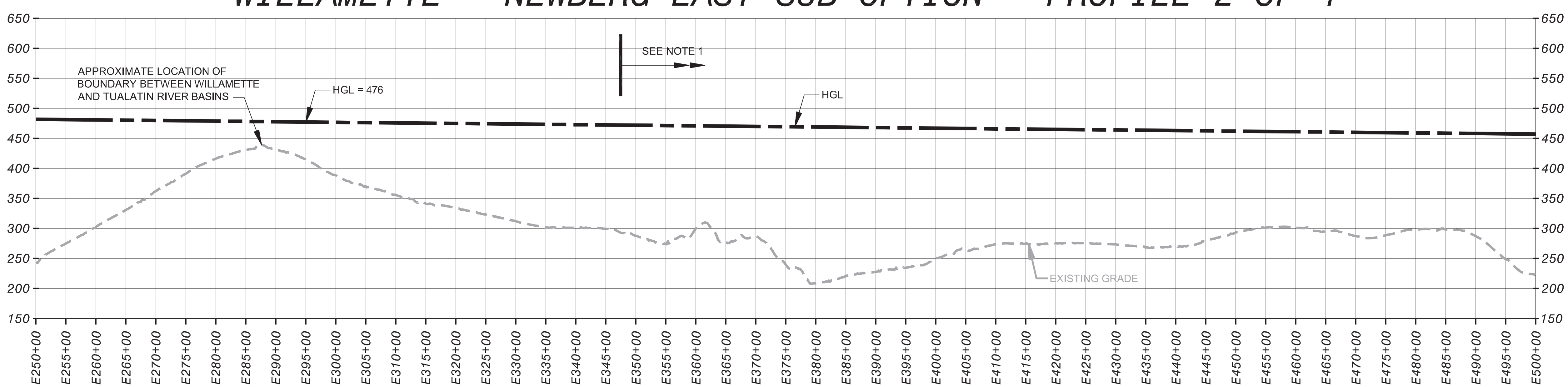
WILLAMETTE - NEWBERG EAST SUB-OPTION - PROFILE 1 OF 4



NOTE:

1. THIS PROFILE WAS DEVELOPED BEFORE AN ALIGNMENT CHANGE WAS MADE FOR THE CROSSING OF THE TUALATIN RIVER NORTH OF SHERWOOD BETWEEN STATIONS E347+50 AND E568+70. THE LENGTH OF THE ALIGNMENT INCREASED BY 10,700 LF. THE MAXIMUM GROUND SURFACE ELEVATION OF THE NEW SECTION OF THE ALIGNMENT IS THE SAME AS THE OLD SECTION. THE HYDRAULIC GRADE LINE OF THE LONGER ALIGNMENT WAS UPDATED ON THIS FIGURE, BUT NOT THE GROUND SURFACE OR STATIONING.

WILLAMETTE - NEWBERG EAST SUB-OPTION - PROFILE 2 OF 4



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100' 50' 0 100' 200'
1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

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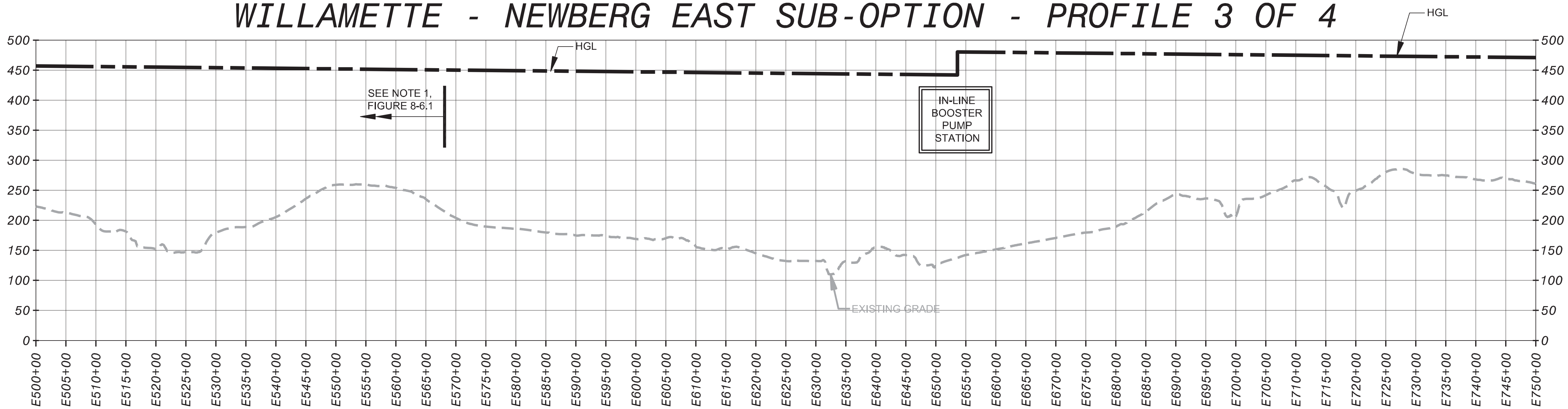
Portland, Oregon

CITY OF OF HILLSBORO
WILLAMETTE - NEWBERG SUPPLY OPTION

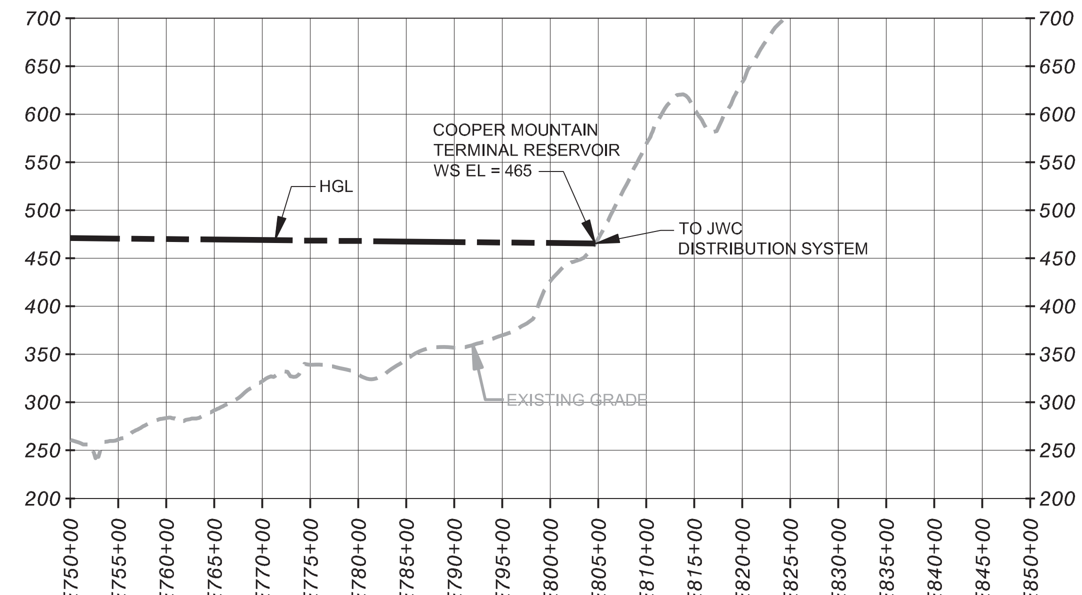
TRANSMISSION PIPELINE - EAST OPTION
PROFILE SHEET 1 OF 2

PROFILE
8-5.1

WILLAMETTE - NEWBERG EAST SUB-OPTION - PROFILE 3 OF 4



WILLAMETTE - NEWBERG EAST SUB-OPTION - PROFILE 4 OF 4



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100' 0 100' 200'
1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

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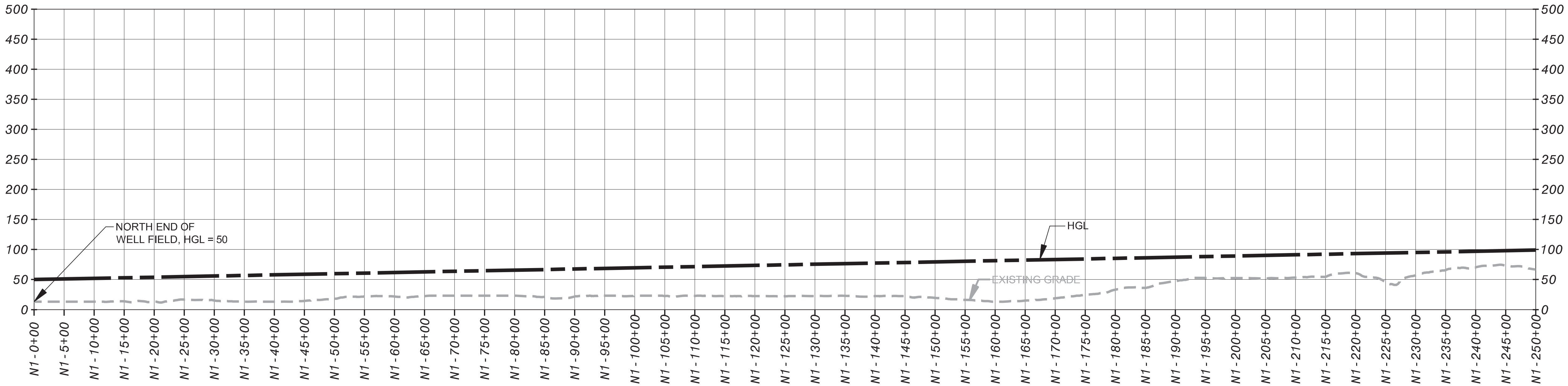
Portland, Oregon

CITY OF OF HILLSBORO
WILLAMETTE - NEWBERG SUPPLY OPTION

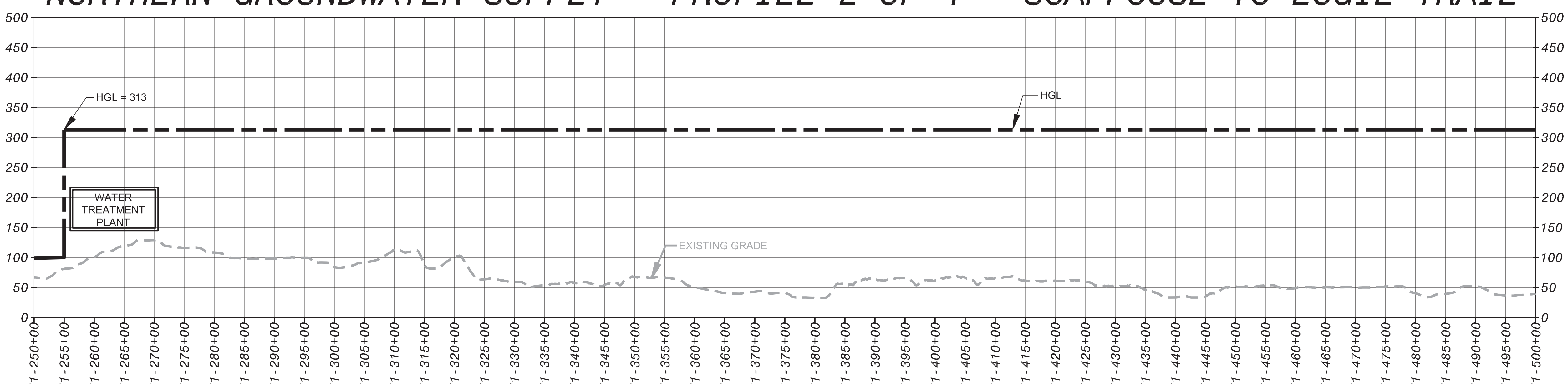
TRANSMISSION PIPELINE - EAST OPTION
PROFILE SHEET 2 OF 2

PROFILE 8-5.2

NORTHERN GROUNDWATER SUPPLY - PROFILE 1 OF 4 - WELLFIELD TO SCAPPOOSE



NORTHERN GROUNDWATER SUPPLY - PROFILE 2 OF 4 - SCAPPOOSE TO LOGIE TRAIL



1000' 500' 0 1000' 2000'

1"=2000' HORIZONTAL SCALE

100' 50' 0 100' 200'

1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

BLACK & VEATCH

Black & Veatch Corporation
Portland, Oregon

CITY OF OF HILLSBORO

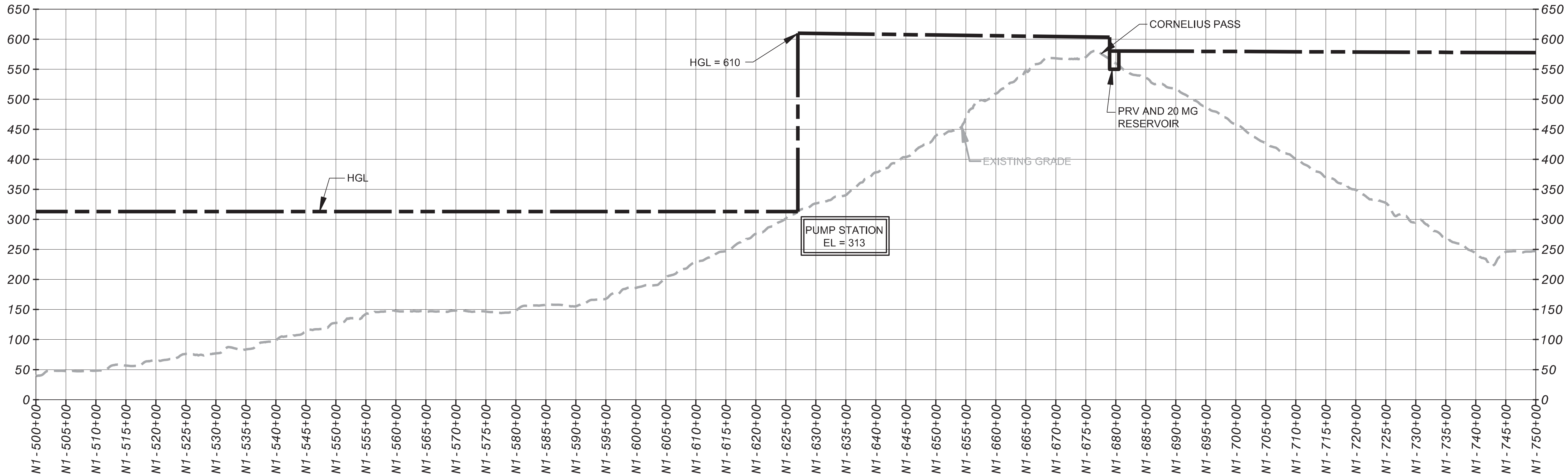
NORTHERN GROUNDWATER SUPPLY OPTION

TRANSMISSION PIPELINE

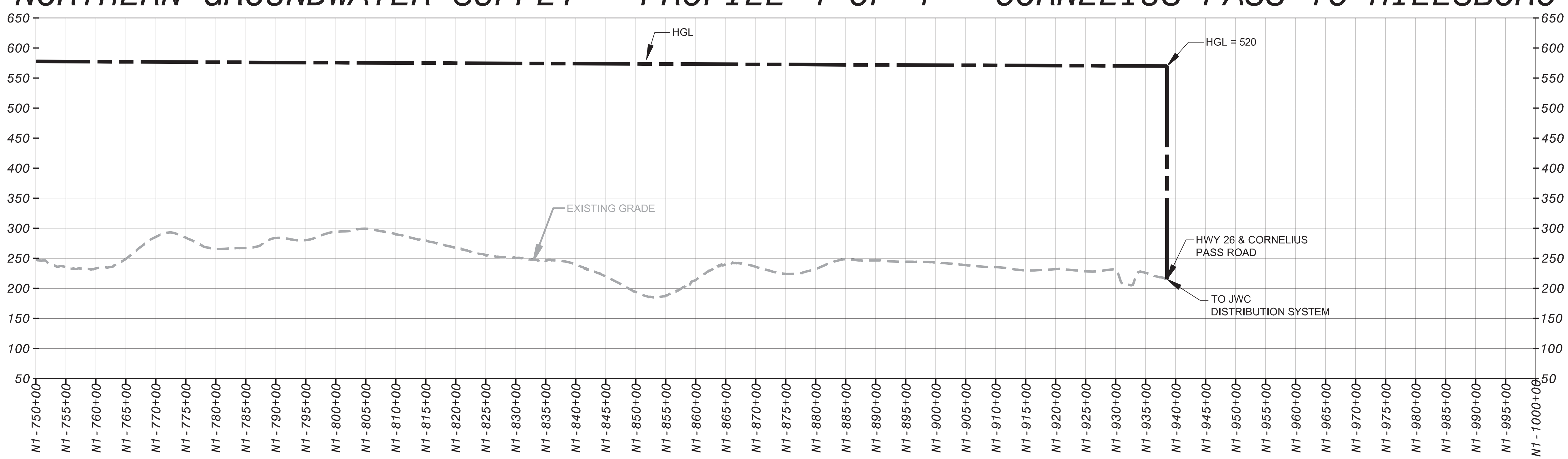
PROFILE SHEET 1 OF 2

PROFILE
8-6.1

NORTHERN GROUNDWATER SUPPLY - PROFILE 3 OF 4 - LOGIE TRAIL TO CORNELIUS PASS



NORTHERN GROUNDWATER SUPPLY - PROFILE 4 OF 4 - CORNELIUS PASS TO HILLSBORO



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1"=200' VERTICAL SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

BLACK & VEATCH
Black & Veatch Corporation
Portland, Oregon

CITY OF OF HILLSBORO
NORTHERN GROUNDWATER SUPPLY OPTION

TRANSMISSION PIPELINE
PROFILE SHEET 2 OF 2

PROFILE
8-6.2

APPENDIX B

Conceptual-Level Pump Station Energy Use Calculations

Concept-Level Pump Station Energy Use Calculations

TBWSP Option:

Design Criteria	Value	Unit	Source	Notes
Pump back pump station, total minimum power req.	3,000	hp	John Dummer 10-6-2011	Total four pump back pumps with VFDs.
	2,238	kW		

New Spring Hill Pumping Plant, total minimum power req.	800	hp	John Dummer 10-6-2011	Total five pumps.
	597	kW		

Concept-Level Pump Station Energy Use Calculations

Willamette-Wilsonville Supply Option:

Design Criteria	Value	Unit	Source	Notes
Wilsonville WTP & conveyance pipeline Capacity	80	mgd		
	55,556	gpm		
Transmission pipeline ID	66	inch	Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	Velocity of 5.5 fps as used for 60" dia at 70 mgd supplied from the Wilsonville WTP in the 2006 Carollo report. Maintaining a similar velocity with standard pipe sizes yields a velocity of 5.2 fps for 66" dia supplying 80 mgd.
Willamette River minimum WS El	52.5	feet	WRWTP Master Plan Final Report, 12/2006, MWH	USGS gage data shows a minimum WS of EL 53.7 feet (NGVD29). Datum for HGL's are not stated, but assumed to all be NGVD29).
Intake headloss	5	feet	Experience with similar intakes.	Includes screen loss and loss through intake pipeline to on-shore raw water pump station caisson.
Wilsonville WTP Clearwell WS El	153.5	feet	From Dec 2006 MWH WRWTP Master Plan Figure 5-5.	
Motor efficiency	90%		Design assumption.	Assumes VFD for each motor. If constant speed were used this would be changed to 95%.
Pump efficiency	80%		Experience with similar pump stations.	
Headloss through WTP	22	feet	Comparison to existing Wilsonville WRWTP and similar conventional WTP's.	Floc basin through high service pump station - see planning-level generic layout.
Headloss through pumping station	5	feet	Jones - Pumping Station Design, rev. 3rd ed., p. 3.8 and experience.	Includes only valves and fittings.
Equivalent Hazen-Williams "C"	140		Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	
Maximum transmission pipeline pressure	150	psi	Design assumption to reduce pipe wall thickness.	
Minimum pipeline pressure	10 - 20	psi	Design assumption to prevent vacuum formation at pipeline high points.	
Transmission pipeline headloss	0.094	ft/100 ft	Based on Hazen-Williams Equation	
Intake in Willamette River, headloss	2.4	feet		
Raw water pipeline headloss - intake to Raw Water Pump Station	12.0	feet	Estimated	
Intake pump station TDH	149	feet		
Intake pump station, total minimum power req.	2,904	hp		Includes pump and motor efficiency losses.
	2,167	kW		
Raw/finished water pipe length - intake to CM Terminal Reservoir	13.60	mi		
	71,800	feet	Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	
Cooper Mountain Terminal Reservoir (CMTR) WS El	465	feet	Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	Ground elevation of proposed reservoir location is around El 630 feet, so reservoir may be located lower on hill during detailed design.
Raw water pipeline headloss - WRWTP to CMTR	67.8	feet		
Wilsonville WTP FW pump station discharge HGL EL	533	feet		
	164	psi		
Wilsonville WTP FW pump station TDH	384	feet		
Wilsonville WTP pump station, total minimum power req.	7,495	hp		Includes pump and motor efficiency losses.
	5,591	kW		
See Portland Option Tab for Booster Pump Station at Beaverton Meter				Pump station capacity and hydraulic gradelines are the same as the Portland Option.

Concept-Level Pump Station Energy Use Calculations

Portland Supply Option:

Design Criteria	Value	Unit	Source	Notes
Conveyance pipeline Capacity	38	mgd		This is less than total into the basin since the existing Washington County Supply Line (WCSL) has 42 MGD capacity. The Carollo 2010 report showed a total capacity of 109.5 mgd into the basin. This was reduced to 80 mgd.
	26,389	gpm		
Transmission pipeline ID	48	inch	Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	Velocity of 5.5 fps as used for 60" dia at 70 mgd supplied from the Wilsonville WTP in the 2006 Carollo report. Maintaining a similar velocity with standard pipe sizes yields a velocity of 4.7 fps for 48" dia supplying 38 mgd.
Powell Butte Reservoir WS El	530	feet	Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	
Equivalent Hazen-Williams "C"	140		Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	
Transmission pipeline headloss	0.112	ft/100 ft	Based on Hazen-Williams Equation	
Finished water pipe length - Powell Butte Reservoir to Terminus of 66"	21.12	mi		
	111,500	feet	Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	
Finished water pipeline headloss - Powell Butte Res to Terminus of 66"	125	feet		
Calculated Terminus HGL	405	feet	Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	Does not match HGL=468 feet shown at Portland Meter in Figure 1.
Conveyance pipeline Capacity	38	mgd		
	26,389	gpm		
Transmission pipeline ID	48	inch		
Equivalent Hazen-Williams "C"	140		Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	
Transmission pipeline headloss	0.112	ft/100 ft	Based on Hazen-Williams Equation	
Finished water pipe length - Portland Meter to connection with Hillsboro Extension	3.09	mi		
	16,300	feet	0	
Finished water pipeline headloss - Terminus of 66" to Term of 60"	18	feet		
Calculated Terminus HGL	387	feet	0	Close, but does not match HGL=438 feet shown at Portland Meter in Figure 1.

Design Criteria	Value	Unit	Source	Notes
Conveyance pipeline Capacity	38	mgd		Upsized flow from 36 mgd to 38 mgd, same pipe size to allow back and forth flow transfer.
	26,389	gpm		
Transmission pipeline ID	48	inch		As used for 100 mgd supplied from the Wilsonville WTP.
Equivalent Hazen-Williams "C"	140		Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	
Transmission pipeline headloss	0.112	ft/100 ft	Based on Hazen-Williams Equation	
Finished water pipe length - Terminus of 66" to Term of 60"	2.61	mi		
	13,800	feet	0	
Finished water pipeline headloss - Terminus of 66" to Term of 60"	15	feet		
Calculated Terminus HGL	371	feet	0	Close, but does not match HGL=438 feet shown at Portland Meter in Figure 1.
Headloss through pumping station	5	feet	Jones - Pumping Station Design, rev. 3rd ed., p. 3.8 and experience.	Includes only valves and fittings.
Motor efficiency	90%		Design assumption.	Assumes VFD for each motor. If constant speed were used this would be changed to 95%.
Pump efficiency	80%		Experience with similar pump stations.	
Booster pump station at Beaverton Meter discharge HGL EL	498	feet	Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	
Booster pump station at Beaverton Meter, TDH	132	feet		
Booster pump station at Beaverton Meter, total minimum power req.	1,221	hp		Includes pump and motor efficiency losses.
	911	kW		

Concept-Level Pump Station Energy Use Calculations

Willamette-Newberg Supply Option:

Design Criteria Common to both Alignments

Design Criteria	Value	Unit	Source	Notes
Newberg WTP & conveyance pipeline Capacity	80	mgd		Refer to Figure 8-2 Willamette-Newberg Supply Option for plan locations.
	55,556	gpm		
Transmission pipeline ID	66	inch	Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	Velocity of 5.5 fps as used for 60" dia at 70 mgd supplied from the Wilsonville WTP in the 2006 Carollo report. Maintaining a similar velocity with standard pipe sizes yields a velocity of 5.2 fps for 66" dia supplying 80 mgd.
Willamette River minimum WS El	52.5	feet	WRWTP Master Plan Final Report, 12/2006, MWH	USGS gage data shows a minimum WS of EL 53.7 feet (NGVD29). Datum for HGL's are not stated, but assumed to all be NGVD29).
Intake headloss	5	feet	Experience with similar intakes.	Includes screen loss and loss through intake pipeline to on-shore raw water pump station caisson.
Newberg WTP existing grade El/ Clearwell WS El	170	feet	For potential sites around Newberg.	
Newberg WTP Inlet WS El	192	feet	Based on headloss through WTP added to ground elevation.	
Motor efficiency	90%		Design assumption.	Assumes VFD for each motor. If constant speed were used this would be changed to 95%.
Pump efficiency	80%		Experience with similar pump stations.	
Headloss through WTP	22	feet	Comparison to existing Wilsonville WRWTP and similar conventional WTP's.	Floc basin through high service pump station - see planning-level generic layout.
Headloss through pumping station	5	feet	Jones - Pumping Station Design, rev. 3rd ed., p. 3.8 and experience.	Includes only valves and fittings.
Equivalent Hazen-Williams "C"	140		Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	
Maximum transmission pipeline pressure	150	psi	Design assumption to reduce pipe wall thickness.	
Minimum pipeline pressure	10 - 20	psi	Design assumption to prevent vacuum formation at pipeline high points.	
Transmission pipeline headloss	0.094	ft/100 ft	Based on Hazen-Williams Equation	
Intake in Willamette River, headloss	2.4	feet		
Raw water pipe length - intake to N WTP	2.4	mi		
	12,672	feet		
Raw water pipeline headloss - intake to N WTP	12.0	feet		
Intake pump station discharge HGL EL	204	feet		
	66	psi		
Intake pump station TDH	159	feet		
Intake pump station, total minimum power req.	3,099	hp		Includes pump and motor efficiency losses.
	2,312	kW		

Design Criteria	Value	Unit	Source	Notes

Newberg West Alignment Design Criteria

Design Criteria	Value	Unit	Source	Notes
Existing grade at JWC WTP	180	feet		
JWC Fern Hill Reservoirs WS El	520	feet	JWC 2009 Master Plan, Final March 2009, B&V	
Finished water pipe length - N WTP to JWC WTP	18.7	mi		
	98,628	feet		
Finished water pipeline headloss - N WTP to JWC WTP	93.1	feet		
N WTP FW pump station discharge HGL EL	366	feet		
	85	psi		
N WTP FW pump station TDH	201	feet		
N WTP FW pump station, total minimum power req.	3,917	hp		Includes pump and motor efficiency losses.
	2,922	kW		
West alignment high point existing grade El	260	feet		El 210 is the high point in the floodplain which is lower than adjacent roadways. Following existing roadways, the high point goes up to approx EL 260.
Finished water pipe length - N WTP to high point	11.97	mi		
	63,202	feet		
Finished water pipeline headloss - N WTP to high point	59.6	feet		
HGL at west alignment high point	306	feet		
Minimum design pressure at alignment high point	20	psi		
Inlet HGL at FW pump station at JWC WTP	273	feet		
Finished water pipe length - JWC WTP to Fern Hill Res.	1.10	mi	Estimated from quad map.	
	5,800	feet		
Finished water pipeline headloss - JWC WTP to Fern Hill Res.	5.5	feet		
In-line FW pump station at JWC WTP discharge HGL EL	525	feet		
	150	psi		
In-line FW pump station at JWC WTP, TDH	258	feet		
In-line FW pump station at JWC WTP, total minimum power req.	5,028	hp		Includes pump and motor efficiency losses.
	3,751	kW		

Newberg East Alignment Design Criteria

Design Criteria	Value	Unit	Source	Notes
Cooper Mountain Terminal Reservoir (CMTR) WS El	465	feet	Hillsboro Economic Evaluation of Water Supply Alternatives, Final 2/2010, Carollo	Ground elevation of proposed reservoir location is around El 630 feet, so reservoir may be located lower on hill during detailed design.
Finished water pipe length - N WTP to CMTR	15.2	mi		
	80,228	feet		
Finished water pipeline headloss - N WTP to CMTR	75.7	feet		
N WTP FW pump station discharge HGL EL	493	feet		
	140	psi		
N WTP FW pump station TDH	328	feet		
N WTP FW pump station total minimum power req.	6,400	hp		Includes pump and motor efficiency losses.
	4,774	kW		
East alignment high point existing grade El	430	feet		At "Rex" on Highway 99.
Finished water pipe length - N WTP to high point	3.4	mi		
	17,952	feet		
Finished water pipeline headloss - N WTP to high point	16.9	feet		
HGL at east alignment high point	476	feet		
Minimum design pressure at alignment high point	20	psi		
Finished water pipe length - High Point (Rex) to CMTR	11.8	mi		
	62,276	feet		
Finished water pipeline headloss - High Point (Rex) to CMTR	58.8	feet		
In-line FW pump station NW of Sherwood, TDH	53	feet		
In-line FW pump station NW of Sherwood, total minimum power req.	1,026	hp		Includes pump and motor efficiency losses.
	766	kW		

Note: 1. General sources of information were from the Carollo report and MWH Treatment plant expansion report.

Concept-Level Pump Station Energy Use Calculations

Northern Groundwater Supply Option:

Design Criteria	Value	Unit	Source	Notes
Delivery rate	80	mgd		
Delivery rate	55,555	gpm		
Water surface elevation in wells	-100	feet		GSI
Ground surface at water treatment plant	60	feet		
Static head from wells to water treatment plant	160	feet		
Wellfield pipeline length	38,000	feet		
Headloss in wellfield pipeline	20	feet		
Pump TDH including static lift and line loss	180	feet		
Total well pump horsepower	3,000	hp		
Cornelius Pass	590	feet		
HGL at Cornelius Pass	600	feet		Need to maintiain additional 10 feet of head to maintain positive pressure
Finished water pipeline length from water treatment plant to Cornelius pass	42,000	feet		
Headloss in 66-inch transmission pipeline	40	feet		
Total static lift from water treatment plant to Cornelius Pass	540	feet		
Total transmission pump TDH	580	feet		
Total transmission pump horsepower	10,000	hp		Split horsepower 50% at water treatment plant and 50 percent at McCarthy Creek Booster Pump Station
Additional power for treatment plant reverse osmosis units	1,800	hp		
Total connected horsepower	14,800	hp		
Total electrical load from pumping	11,041	kw		

APPENDIX C

Northern Groundwater Supply Option TM

Updated Hydrogeological Evaluation and Water Rights Review of the Northern Groundwater Supply Option

Hillsboro Water Master Plan Alternatives Northern Groundwater Supply Option

PREPARED FOR: City of Hillsboro

PREPARED BY: Joe Broberg, PE, BCEE, PMP

COPIES: Brad Phelps, PE

DATE: December 2, 2011

The City of Hillsboro is evaluating long term water supply options that will deliver 80 million gallons per day (mgd) of treated water. This memorandum describes one of those alternatives, the Northern Groundwater Supply Option (NGSO). NGSO would draw water from a new wellfield constructed between the City of Scappoose and Multnomah Channel, filter and treat the water to remove potential raw water impurities such as iron, manganese, and other dissolved solids, and then pump the water through a new pipeline to connect to the existing Joint Water Commission (JWC) system on the south side of Highway 26 at Cornelius Pass Road. Figure 8-2E shows the configuration of the proposed system.

NGSO Components

The components of the NGSO are shown in Figure 8-2E and include:

1. Wellfield – The proposed wellfield would be constructed between the City of Scappoose and Multnomah Channel. It would have a total capacity of 80 mgd, pumped from 8 radial collector wells, each with a capacity of 10 mgd.
2. Pipelines – Total pipeline length of 135,700 (25.7 miles). A pipeline with a length of approximately 115,000 feet (21.8 miles) and diameters of 24 inches to 66 inches would convey water from the wellfield to the JWC system. Approximately 38,000 feet (7.2 miles) of the pipeline would convey water from the wellfield to a new water treatment plant. The remaining 77,000 feet (14.6 miles) would convey treated water from the water treatment plant to the JWC system, crossing the Tualatin Mountains near Cornelius Pass. Highway, railroad, and larger or sensitive stream crossings would be microtunneled. Approximately 20,700 ft (3.9 miles) of pipeline continues south along Cornelius Pass Road to connect the North and South transmission pipelines. This pipeline connects both dead-ends adding redundancy to the system in case one transmission pipeline is out of service.

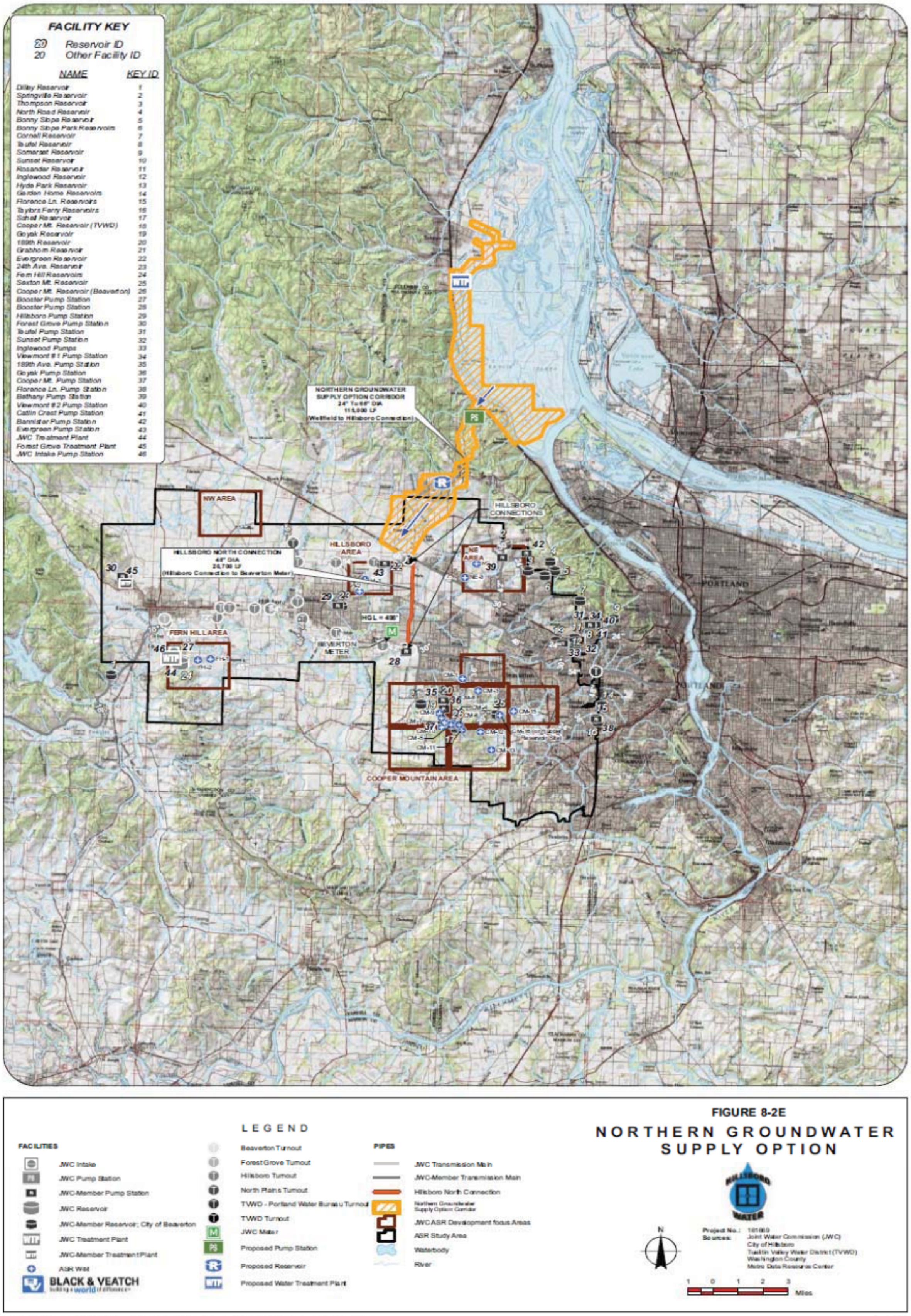

FIGURE 8-2E
NORTHERN GROUNDWATER SUPPLY OPTION

3. Water treatment plant – A water treatment plant would be constructed at some point along the pipeline from the wellfield to the connection to the JWC system. For planning purposes, it has been assumed that the plant would be constructed near the wellfield in Scappoose. The source is assumed to be groundwater under the influence of surface water. The treatment plant would oxidize iron and manganese, use dual media filters to remove iron and manganese and turbidity, and provide split stream treatment using reverse osmosis to remove dissolved solids to produce water similar to that currently delivered by the JWC system. The water would be chlorinated. The treatment plant would include a 20 million gallon (MG) clearwell, a treated water pumping station, and lagoons for backwash water treatment.

4. Booster pumping station – A booster pumping station would be constructed along the pipeline at an elevation of approximately 320 feet. Dividing the transmission pipeline lift into two stages will keep maximum operating pressures to approximately 120 psi. If operating pressures of 240 psi were acceptable, all pumping could be provided at the water treatment plant.

5. Treated water storage – A reservoir with 20 MG of treated water storage would be constructed between Cornelius Pass and Highway 26.

System Hydraulics and Electrical Power Usage

Pumps with total driver capacity of approximately 13,000 horsepower (hp) would be needed to convey water from the wellfield to the JWC system, providing a total lift of approximately 714 feet, including friction losses in the pipeline. Pumping would be provided in three lifts. The first lift of approximately 160 feet would be from the water surface in the wells at an elevation of -100 feet (assumes water surface in the well is 50 feet above the bottom of the well during peak pumping conditions) to the water treatment plant at an elevation of 60 feet, using 400 hp pumps in each well. The remaining lift of approximately 554 feet from the treatment plant to the high point at Cornelius Pass would be split into two stages, each providing 227 feet of lift to keep maximum pipeline pressures at approximately 120 psi. A pump station would be provided at the water treatment plant and a booster pumping station would be constructed at an elevation of approximately 320 feet along the pipeline route between the water treatment plant and Cornelius Pass. Treatment processes at the water treatment plant would require an additional 1,800 hp of pumping capacity, making the total connected load approximately 14,800 hp.

At a continuous production rate of 80 mgd ,overall wire-to-water pump efficiency of 80 percent, motor efficiency of 90 percent, and a 2011 average electrical power cost of $0.07 per kilowatt-hour (kWh), the annual cost of electrical power is estimated to be approximately $7,520,000. The electrical power rate is based on rate schedules obtained from Columbia River PUD (CRPUD) and Portland General Electric (PGE). CRPUD supplies Power in Columbia County where the wellfield and treatment plant will be located. PGE supplies power in Multnomah and Washington counties where the booster pumping station and reservoir will be located. Both utilities charge for demand and energy usage. The average rate for a baseloaded large industrial CRPUD customer would currently be approximately $0.053 per kWh using CRPUD Rate Schedule 24. The average rate for a baseloaded PGE customer would be approximately $0.068 per kWh. For planning purposes, the higher PGE rate was used, recognizing that there actual power costs may be somewhat lower if a significant portion of the load can be served from the CRPUD system. Therefore, an average rate of $0.07 per kWh was used to compare alternatives.

The high point on the pipeline alignment is Cornelius Pass at an elevation of approximately 570 feet. This is approximately 50 feet higher than the minimum hydraulic grade line needed at that point, based on delivering water to the JWC system at a hydraulic grade line of 520 feet. A tunnel with an approximate length of 3,000 feet could be constructed at an elevation 520 feet to reduce the pumping head, saving approximately $560,000 in electrical power costs each year. Additional savings in electrical power costs could be achieved by constructing a longer tunnel at a lower elevation if a point of delivery to the JWC system with a lower hydraulic grade line could be identified.

Wellfield

In the attached draft technical memorandum "Updated Hydrogeological Evaluation and Water Rights Review of the Northern Groundwater Supply Option," prepared for the City of Hillsboro dated April 12, 2011, GSI Water Solutions, Inc. concluded that it might be possible to construct a wellfield producing up to 40 to 80 mgd or more on the west bank of Multnomah Channel between the City of Scappoose and Multnomah Channel. Data allowing a more precise determination of expected yield is not currently available and would need to be obtained before finalizing the evaluation. For planning purposes, it has been assumed that a total of eight radial collector wells, each with a capacity of 10 mgd, would be constructed. Additional water rights investigations and test pumping will be needed to estimate possible yields, determine possible impacts on existing water rights holders and environmental uses of water, verify that the well sites would not be adversely affected by environmental contamination, and develop design criteria for the wells. It is assumed that water from the wells would be classified as groundwater under the influence of surface water, requiring treatment to remove microbiological contaminants.

The lack of aquifer data prevented specific locations for each well from being identified. For planning purposes, CH2M Hill assumed that eight wells would be constructed along a wellfield corridor 38,000 feet (7.2 miles) in length generally along the west bank of Multnomah Channel. Water from the wells is assumed to be classified as groundwater under the influence of surface water, requiring treatment to remove microbiological contaminants. Each well would have a capacity of 10 mgd and would consist of a reinforced concrete caisson with a diameter of 20 feet completed at a depth of approximately 150 feet below the surface. At peak pumping rates, it is assumed that the depth of water in the well would 50 feet above the bottom of the well (100 feet below the surface). Radial collector screens would draw water from the aquifer into the well. Each well would be equipped with vertical turbine pumps with submersible motors, electrical control equipment, and a standby generator. It is assumed that the local electrical power provider (Columbia River PUD) will provide power at each well site and that each well will be individually metered. The caisson would be completed above the flood elevation of 33 feet in Multnomah Channel. The ground elevation at the well sites would be approximately 10 to 15 feet, making the height of the caisson approximately 9 to 23 feet above ground surface. Site improvements would include a gravel access road, fencing, gates, and landscaping.

The feasibility of constructing radial collector wells at a depth of 150 feet was reviewed with representatives of Ranney Collector Wells (Ranney), a division of Layne Christensen Company, a company specializing in the construction of radial collector wells. Ranney provided a list of 12 collector wells that have been completed at depths of 140 to 155 feet in alluvium since 1950, including three constructed for Washington Public Service. The caisson construction method constructs open-end caisson sections up to approximately 20 feet in diameter at grade and then sinks the caissons by excavating the soil inside the caisson. The caisson sinks into the ground until the required depth is reached. The depth to which a caisson can be sunk is limited by skin friction on the caisson and hydrostatic pressures that may cause soil to flow uncontrollably into the bottom of the caisson as the caisson sinks deeper. Weight assisted, synchronized hydraulic jacking systems and a bentonite lubrication system are used to overcome soil friction for deeper installations. Additional soils data would be needed at the site of each proposed collector well to evaluate site-specific geologic conditions affecting the suitability of caisson construction for the NGSO wellfield.

Pipelines

Total pipeline length of 135,700 (25.7 miles). Approximately 115,000 feet (21.8 miles) of pipelines with diameters from 24 inches to 66 inches would be constructed to convey water from the wellfield to the water treatment plant and then to Hillsboro, connecting the JWC system on the south side of the intersection of Highway 26 and Cornelius Pass Road. A reconnaissance-level investigation was undertaken to locate and evaluate possible pipeline routes. The investigations included driving the full alignment of the pipeline to verify field conditions for installation of the pipe and reviewing aerial photographs, property maps, and zoning maps covering the alignment. A feasible corridor paralleling Highway 30 from Scappoose to Cornelius Pass Road and then paralleling Cornelius Pass Road from Highway 230 to Highway 26 was identified and is shown in Figure 8-2E. Approximately 20,700 ft (3.9 miles) of pipeline continues south along Cornelius Pass Road to connect the North and South transmission pipelines. This pipeline connects both dead-ends adding redundancy to the system in case one transmission pipeline is out of service.

The pipeline would be constructed using ductile iron pipe for pipe diameters of 30 inches and smaller, rubber gasketed steel pipe for pipe diameters of 36 to 48 inches, and welded steel pipe for pipe diameters of 54 inches and larger. Ductile iron pipe would be encased in polyethylene sleeves. The steel pipe would be mortar coated and lined. Initial planning has assumed that all pipes would be placed within public rights-of-way. As the project proceeds, consideration should be given to alternatives on private land paralleling the roadways. It may be cost effective to tunnel the higher portions of the system, reducing pumping head and minimizing construction impacts on roadways. Where pipe would be constructed under a paved street or highway, bedding and backfill was assumed to be controlled density fill. Bedding and backfill for the remaining pipe was assumed to be imported fill. Dewatering was assumed to be required for all trenches. Railroad and highway undercrossings would be microtunneled. Line valves would be provided at intervals of 5000 feet (0.95 miles) for pipe 48 inches in diameter and smaller and at intervals of 10,000 feet (1.9 miles) for pipe diameters exceeding 48 inches. Blowoff connections and air relief valves would be provided where terrain dictates and are expected to be placed at intervals averaging 10,000 feet (1.9 miles).

Water Treatment Plant

The City of Hillsboro has concluded that treated water quality from the NGSO would need to be similar to that provided by the JWC system. Water quality data from the proposed wellfield is not currently available. If this option was pursued, test wells would need to be constructed to obtain water samples as well as verify proposed pumping rates. Until test results from sampling are available, it is assumed that the groundwater would be similar to that produced from the City of Portland Columbia Wellfield and other wells drawing from sand and gravel aquifers along the Columbia River. Technical Memorandum 6 summarizes water quality of the new sources being considered by the City Hillsboro. The groundwater may contain iron, manganese, and dissolved solids at concentrations exceeding customer acceptance limits and is also assumed to be classified as groundwater under the influence of surface water, requiring treatment to remove potential microbiological contaminants. The groundwater could have dissolved solids concentrations as high as 180 mg/l, which is approximately twice the concentration of dissolved solids in water from the JWC system. To meet this treatment goal, a split stream treatment process would be used. All of the water would be treated to oxidize iron and manganese, filtered in dual media filters, and disinfection using chlorine. Additional treatment using ozone and GAC filters to remove organic constituents is not anticipated at this time but can be easily added in future study without materially altering the present worth valuation of this option should water sampling warrant that technology. Following these treatment steps, approximately half the flow would be treated using reverse osmosis to remove dissolved solids. Water from the reverse osmosis system would be blended with the remaining water that has been conventionally treated to produce a blended water with 80 mg/l total dissolved solids.

The water treatment plant could be sited anywhere along the pipeline route from the wellfield to Hillsboro. For planning purposes, it has been assumed that the plant would be constructed near the wellfield in Scappoose. In addition to the processes listed above, the plant would also include a 20 MG clearwell and a booster pumping station drawing from the clearwell and pumping to the McCarthy Creek Booster Pumping Station. Treatment equipment would be housed in a building to protect it from freezing during winter weather. It is assumed that an emergency power generator will be needed. Backwash water would be decanted in storage lagoons. The decant would be recycled through the water treatment plant. Brine from the reverse osmosis units would treated in a brine concentrator and a crystallizer. Based on information from other construction projects in the Scappoose area, it was assumed that foundation conditions will be poor at the water treatment plant site and overexcavation and imported backfill will be required under all structures.

Booster Pumping Station

A booster pumping station would be constructed near McCarthy Creek to limit operating pressures in the pipeline system to 120 psi. The pumping station would consist of lineshaft-driven vertical turbine pumps drawing from a 3.4 MG forebay. An emergency generator would be provided. The forebay, pumps, generators, and electrical controls would be enclosed in a concrete block building. It is assumed that the local power provider (Portland General Electric) can provide power to the site. Site improvements would include a drive, fencing, gates, and landscaping.

Treated Water Storage

A 20 MG treated water storage reservoir would be provided between Cornelius Pass and Hillsboro. The reservoir would be an above grade circular prestressed concrete tank.

DRAFT Technical Memorandum

To: Kevin Hanway – City of Hillsboro
Peter Martins – City of Hillsboro
Niki Iverson – City of Hillsboro

Cc: Alan Peck – Black & Veatch
Brad Phelps – CH2M HILL

From: John Porcello, RG – GSI Water Solutions
Jeff Barry, RG – GSI Water Solutions

Date: April 12, 2011

Re: Updated Hydrogeologic Evaluation and Water Rights Review of the Northern Groundwater Supply Option, City of Hillsboro Water Supply Alternatives Project

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Introduction

As part of its water master plan update, the City of Hillsboro (City) is evaluating the feasibility of developing a groundwater supply near the Columbia River in northwestern Multnomah County and southern Columbia County. The purpose of this study was to evaluate the hydrogeologic feasibility of potentially developing a 50- to 100-million-gallon-per-day (mgd) wellfield in this general area. Developing a groundwater supply in the lowlands of the Columbia River is of interest to the City and its partners because similar lowlands elsewhere along the river contain high-yielding wells and large wellfields that have been successfully developed for large-scale municipal supply. This option for a potential future water supply source, which is called the Northern Groundwater Supply Option, will be compared to other water supply strategies.

Initial evaluations focused on (1) the hydrogeologic feasibility of developing a supply using groundwater production wells (GSI, 2010), and (2) the approaches that could be taken for water rights permitting (GSI, 2011). The hydrogeologic evaluation focused on each of three specific study areas (A, B, and C) as shown in Figure 1. The study concluded that the aquifer could support the development a 100-mgd wellfield within Study Area B, and that this area was well suited to developing a groundwater supply because of (1) its proximity to the intersection of Cornelius Pass Road and Highway 30, where the most likely route for a conveyance pipeline to Washington County would begin; (2) its location where a productive gravel aquifer appears to be thickest underneath the study area; and (3) the small number of existing wells in this area compared with elsewhere.

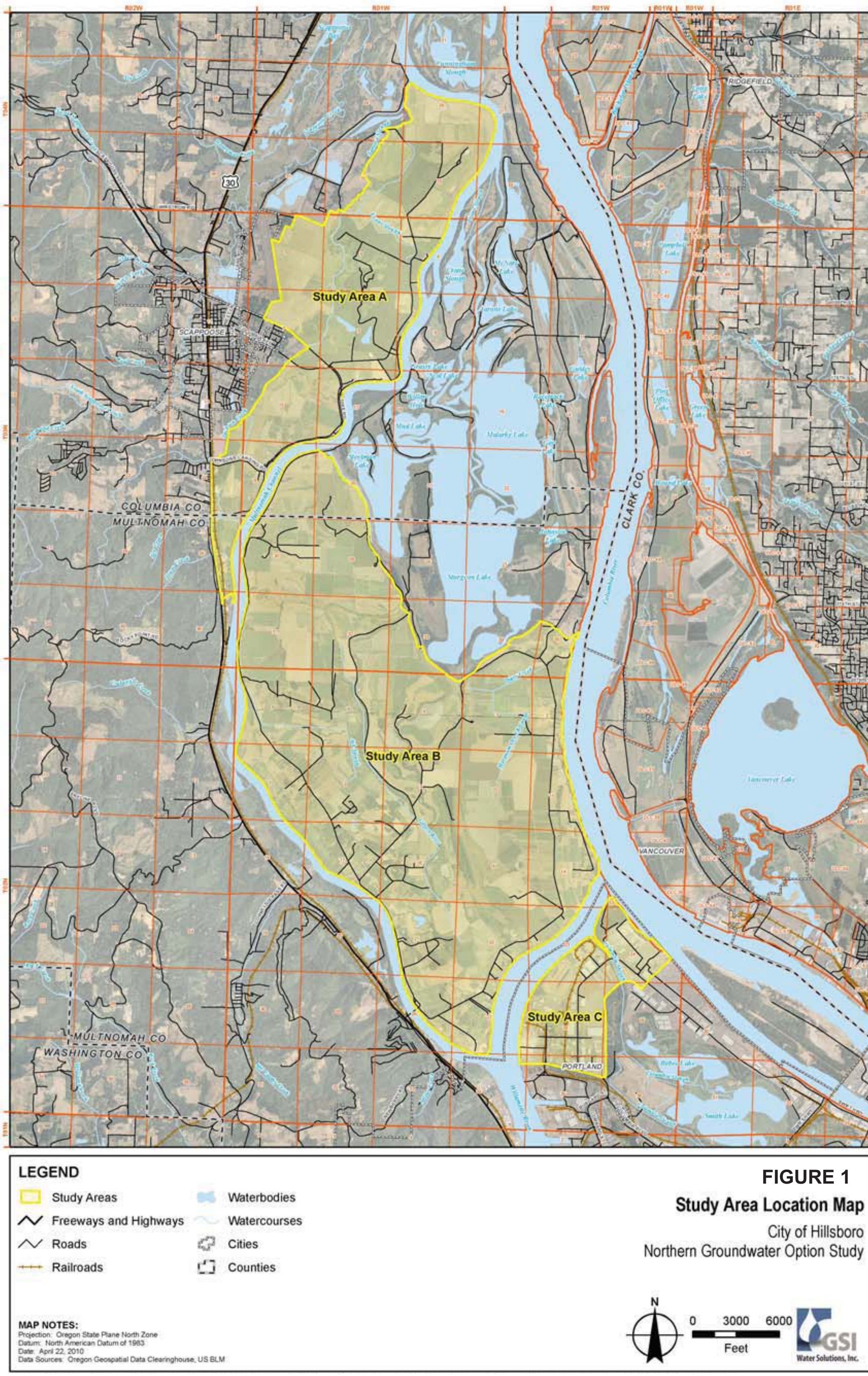


FIGURE 1
Study Area Location Map
City of Hillsboro
Northern Groundwater Option Study

Following issuance of the initial hydrogeologic evaluation report (GSI, 2010), the City and its technical advisory committee (TAC) requested additional analyses to consider the potential feasibility of developing one or more horizontal collector wells in Study Areas A and/or B. This interest arose because collector wells require fewer pumping facilities, less land (and land use impacts), less piping, less access road, and less electrical service than a comparable number of conventional wells designed to achieve a given target yield.

GSI has evaluated a collector well option, in lieu of vertical wells, from a hydrogeologic point of view. This technical memorandum presents this analysis and discusses the following topics:

- The feasibility of the geologic setting in Study Areas A and B as it relates to constructing collector wells
- Siting criteria and the development concept for a wellfield consisting of one or more collector wells, including how the number of collector wells, their spacing, their long-term production rates, and how they might affect other nearby groundwater users
- Water rights permitting alternatives, processes, and potential issues

Feasibility of Geologic Setting for Collector Well Construction

As discussed in Section 4.3 of the initial hydrogeologic evaluation report (GSI, 2010), collector wells are infiltration galleries consisting of a cement caisson and a circular or semicircular array of horizontal lateral well screens that radiate outward beneath a river and along a river shoreline (see Figure 2). Collector wells are frequently installed in an alluvial aquifer along a river shoreline, as they are designed to obtain water via induced infiltration through the bed of the river. Collector wells are used not only to provide a high-capacity water supply, but also to use the river sediments and underlying aquifer material as a natural filter for microbiological organisms, such as cryptosporidium and giardia. While it is common to install collector wells near a river for these reasons, it is also viable to construct collectors farther from a river if the aquifer is highly permeable and has a strong hydraulic connection with the nearest river.

Collector wells are generally several tens of feet deep. In the United States, a few collectors have been installed to depths of 100 feet or greater, with the deepest known collector (owned by the Washington Public Power Supply System) being installed to a depth of 155 feet. Collector wells are commonly completed in aquifers comprised of gravels and/or coarse-grained sands. Because horizontal well screens completed in a radial pattern can target and maximize production from layers of sand and gravel, collector wells are capable of producing large quantities of water relative to conventional vertical wells. As a rule of thumb, collector wells can produce 5 to 7 times what a conventional well may produce at a given location. Because a regionally extensive gravel aquifer is known to exist beneath the Northern Groundwater Option study area and in adjoining areas (such as in southwestern Clark County), the hydrogeologic feasibility of collector well installation will be governed primarily by three specific characteristics of the gravel layer: (1) its permeability, (2) its thickness, and (3) its depth (i.e., the thickness of the overlying silt and sand layers). These topics are discussed below for Study Areas A and B.

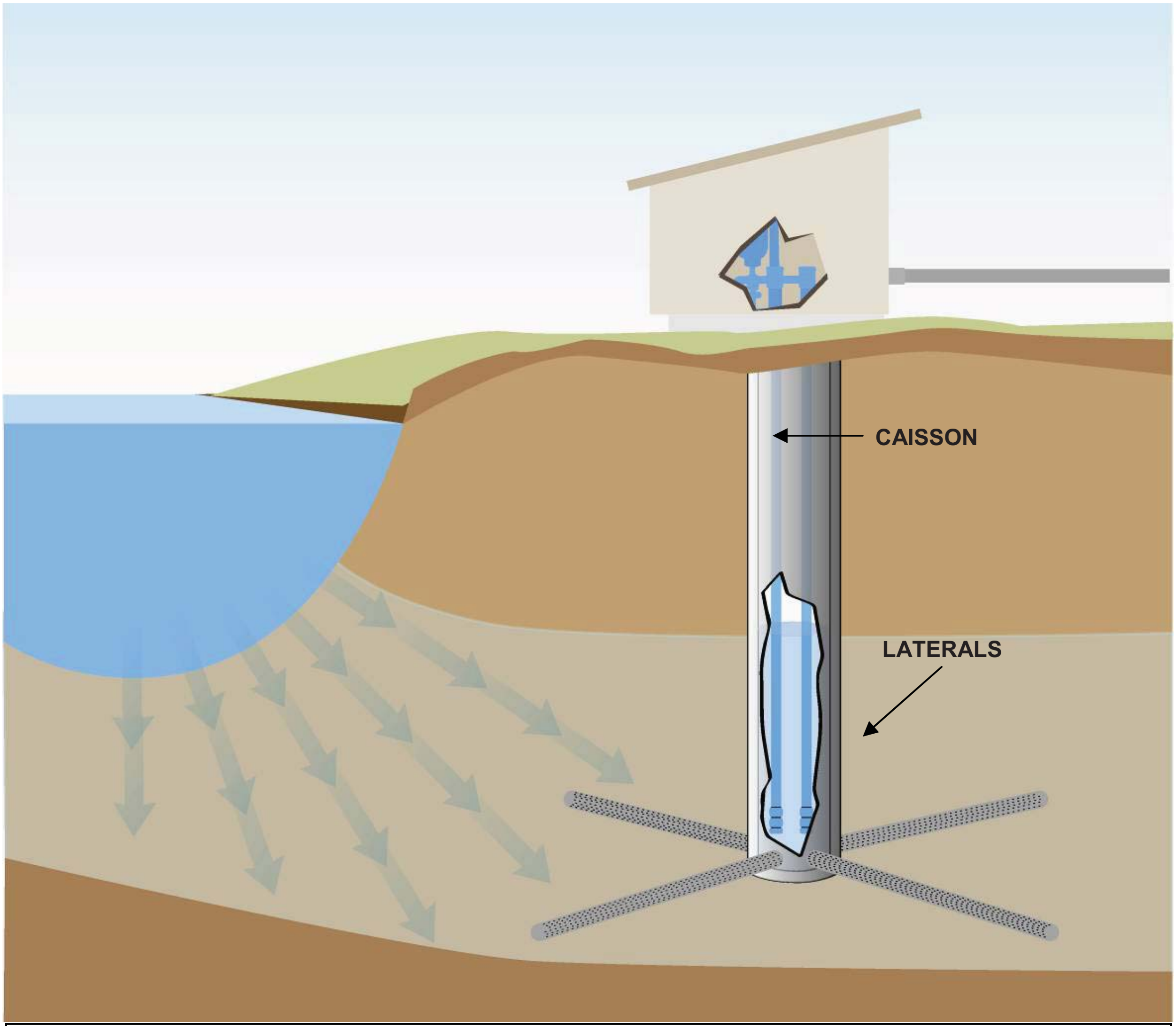


FIGURE 2
Schematic Cross-Section Diagram of a Horizontal Collector Well
City of Hillsboro Northern Groundwater Option Study

Gravel Permeability

As discussed in Section 3.2.1 of the initial hydrogeologic evaluation report (GSI, 2010), long-term controlled aquifer tests in northwest Portland (in Study Area C) and in southwestern Clark County indicate that the gravel unit has a permeability of about 1,600 to 2,100 feet per day (ft/day), but could be as high as 5,000 ft/day. At those locations, the transmissivity of the gravel unit is estimated to be potentially as high as 2 million gallons per day per foot. These estimates of the aquifer's hydraulic properties, together with well yield information, indicate that the groundwater development potential of the gravel unit is high on a regional scale. However, no such data are available in Study Area A, and only limited test data are available in Study Area B. Consequently, for the purposes of further analyses of potential collector well yields (described later in this technical memorandum), the gravel unit is assumed to have a permeability of 1,600 ft/day, which is at the low end of the estimates from long-term controlled aquifer tests in the region.

Gravel Thickness and Depth

The thickest gravels are located in Study Area A. Figure 3 is a contour map of the saturated thickness of the gravel unit in Study Areas A, B, and C. The map shows that the thickest gravels are located in Study Area A and, to a lesser extent, in a northwest-to-southeast trending zone in the middle of Study Area B. Two primary observations that relate to the feasibility of collector wells are as follows:

1. In Study Area A, a southwest-to-northeast trending cross section (B-B′; see Figure 4) shows that the gravels not only are thick in this area, but also lie at a shallow depth and are likely to be in direct contact with the Multnomah Channel; such conditions would be favorable from a hydrogeologic standpoint for collector well siting.
2. In Study Area B, a northwest-to-southeast cross section aligned along the trough of the thickest gravel zone (Section C-C′; see Figure 5) indicates that the gravels lie at depths exceeding 100 feet in some areas and that the nearby major surface water bodies at each end of this cross section likely do not penetrate below the surficial silt unit. A west-to-east cross section (F-F′; see Figure 6) that is perpendicular to the trough also shows that the gravels thin considerably along the western and eastern margins of Study Area B, and that they lie at depths exceeding 150 feet across the eastern one-third to one-half of Study Area B.

Conclusions Regarding Feasibility of the Geologic Setting for Collector Wells

The gravel thickness map and the cross sections together indicate that the gravels in Study Area B are reasonably thick in some locations, they (1) lie deeper than the deepest known collector wells in the United States, and (2) are relatively thin outside the trough that lies in the middle of Study Area B. Additionally, the nearest surface water bodies may not be in hydraulic connection with the gravels, further rendering Study Area B as hydrogeologically infeasible for collector well development. In contrast, Study Area A appears to be quite feasible for collector well development, except in the southwestern corner where the gravels appear to thin considerably (south of the City of Scappoose). The primary uncertainty regarding collector well development in Study Area A is the permeability of the gravels, which can only be estimated from regional information elsewhere because of the absence of aquifer test data in this specific area.

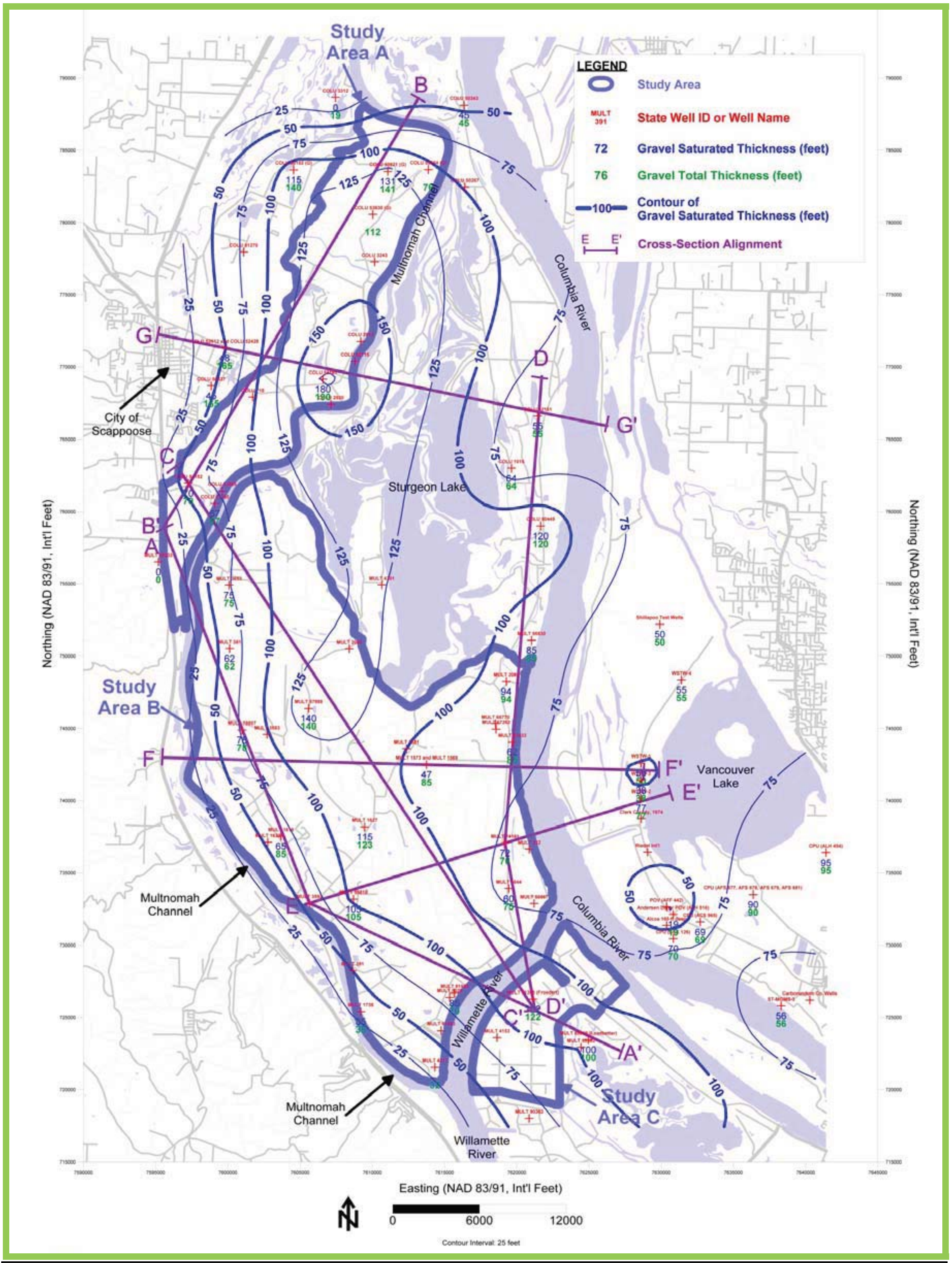


FIGURE 3

Saturated Thickness of Gravel Deposits

City of Hillsboro Northern Groundwater Option Study

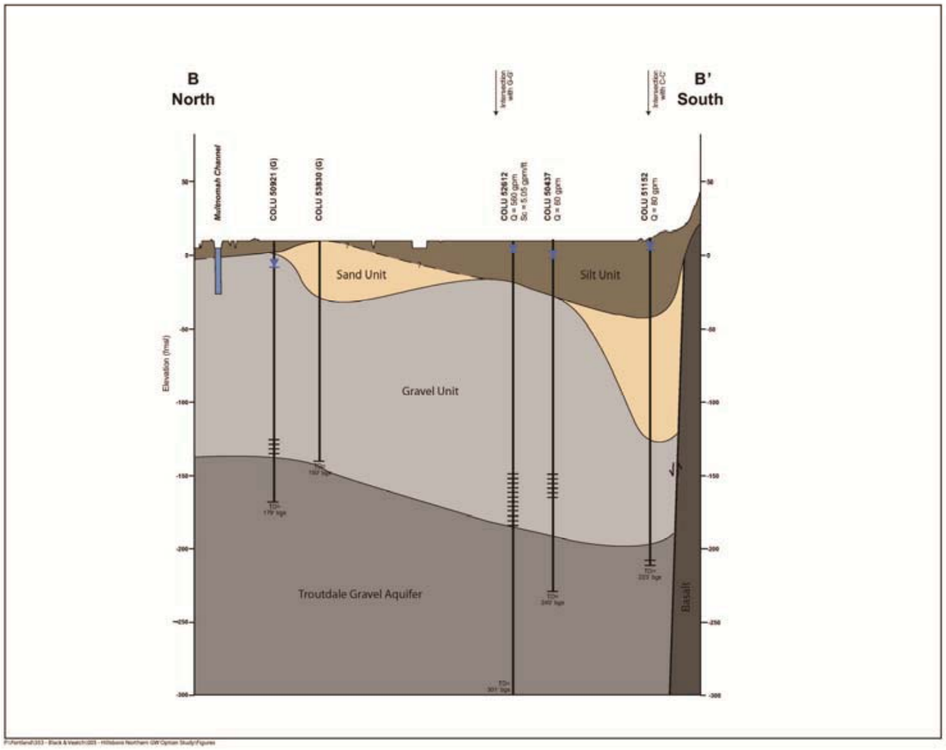


FIGURE 4
Cross Section B-B'
Hillsboro Northern Groundwater Option Study

LEGEND
- Silt Unit
- Sand Unit
- Gravel Unit
- Troutdale Gravel Aquifer
- Basalt
- Static Water Level
- Well
- Well Screen

NOTES
gpm - Gallons per Minute
bgs - Below Ground Surface
Q - Yield
TD - Total Depth
SC - Specific Capacity (included if drawdown data were available)

Scale
50 feet
100x Vertical Exaggeration
5000 feet

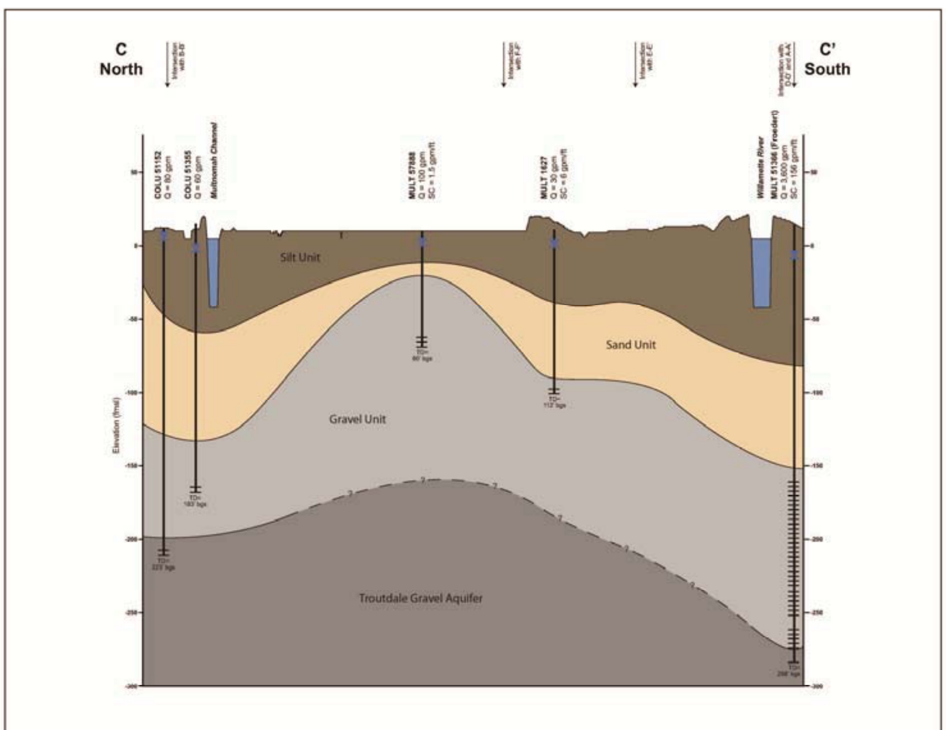
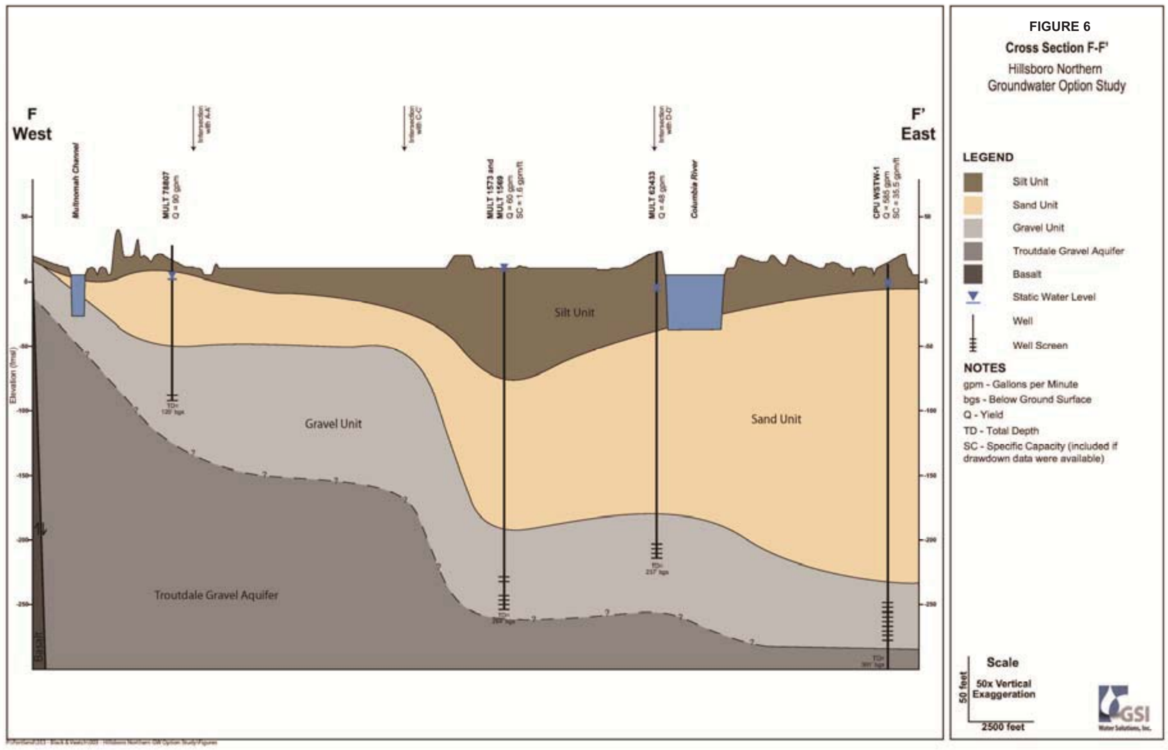


FIGURE 5
Cross Section C-C'
Hillsboro Northern Groundwater Option Study

LEGEND
- Silt Unit
- Sand Unit
- Gravel Unit
- Troutdale Gravel Aquifer
- Static Water Level
- Well
- Well Screen

NOTES
gpm - Gallons per Minute
bgs - Below Ground Surface
Q - Yield
TD - Total Depth
SC - Specific Capacity (included if drawdown data were available)

Scale
50 feet
100x Vertical Exaggeration
5000 feet



Collector Well Siting Criteria

From a hydrogeologic perspective, the primary criteria for selecting locations inside Study Area A to site one or more collector wells are the following:

- **Gravel depth and thickness.** Collector wells are best sited where the thickness of the gravel unit is greatest, and where the top of the gravel is shallow enough to facilitate the construction process and minimize construction costs.

- **Proximity to existing wells and groundwater rights.** Areas with more existing groundwater supply wells will present logistical challenges for siting collector wells, and operational and permitting challenges related to the mutual interference effects that will increase the amount of drawdown in collector wells and privately owned wells.

- **Proximity to known contaminant sources.** Collector wells should not be sited near known contaminant plumes or in areas where accidental spills (for example, along highways or rail lines) or releases from industrial properties could occur that result in extensive groundwater contamination.

- **Proximity to roadways.** Collector well placement near or along roadways will facilitate the construction of conveyance piping.

- **Proximity to surface water.** Siting collector wells so that their laterals are at least 200 feet away from surface water bodies will reduce the potential for having to provide filtration of the water, given the Oregon Health Authority (OHA) Drinking Water Program

(DWP) rules regarding groundwater under the direct influence of surface water (GWUDI). Additionally, the distance from the Multnomah Channel that collector wells are sited could complicate the process for, and conditions on, obtaining a water right (as discussed later in this technical memorandum).

Gravel Thickness and Depth

As discussed previously, the preferred conditions for the gravel thickness (large) and depth (shallow) are well met in Study Area A, except due south of the City of Scappoose where the gravels are much thinner than elsewhere inside this study area.

Proximity to Existing Wells and Groundwater Rights

Figure 7 shows the number of water supply wells that have been identified from a query of the Oregon Water Resources Department's (OWRD) well log database as described in the initial hydrogeologic evaluation (GSI, 2010). The map shows the number of wells in each Public Land Survey (PLS) section. As shown in Figure 7, several wells are present along the west-central margin of Study Area A, but other PLS sections inside Study Area A show fewer than 10 wells per section.

Figure 8 shows the locations and amounts of groundwater rights identified from OWRD's online water rights database during the initial hydrogeologic evaluation (GSI, 2010). The inventory identified the following groundwater rights:

- Study Area A: One certificated right, two permitted rights, and one claim
- West of Study Area A: Seven certificated rights, six permitted rights, and six claims
- North of Study Area A: One certificated right
- North end of Study Area B: One certificated right

Water rights of particular note in these areas are as follows:

- The City of Scappoose holds three municipal groundwater permits (G-8615, G-15295, and G-15491) and one claim (groundwater registration GR-926) that together authorize pumping at a combined rate of 4.458 cfs, which is equivalent to 2,000 gallons per minute (gpm) or 2.88 mgd (assuming continuous pumping during all hours of a given day). The City's largest groundwater right is Permit G-15491, which is a municipal permit. This permit is the largest water right in Study Area A, authorizing 2.23 cubic feet per second (cfs) of pumping, which is equivalent to 1,000 (gpm) or 1.44 mgd (assuming continuous pumping during all hours of a given day).

- Certificate 52819 at the north end of Study Area B is a privately held irrigation water right owned by Fred J. Cholick. The authorized amount of the right is 0.62 cfs, which is equivalent to about 278 gpm, or 0.40 mgd if used continuously.

In addition to these water rights, owners of domestic (exempt) wells also have standing with regard to protection from impacts that might arise from the installation and operation of a collector wellfield.

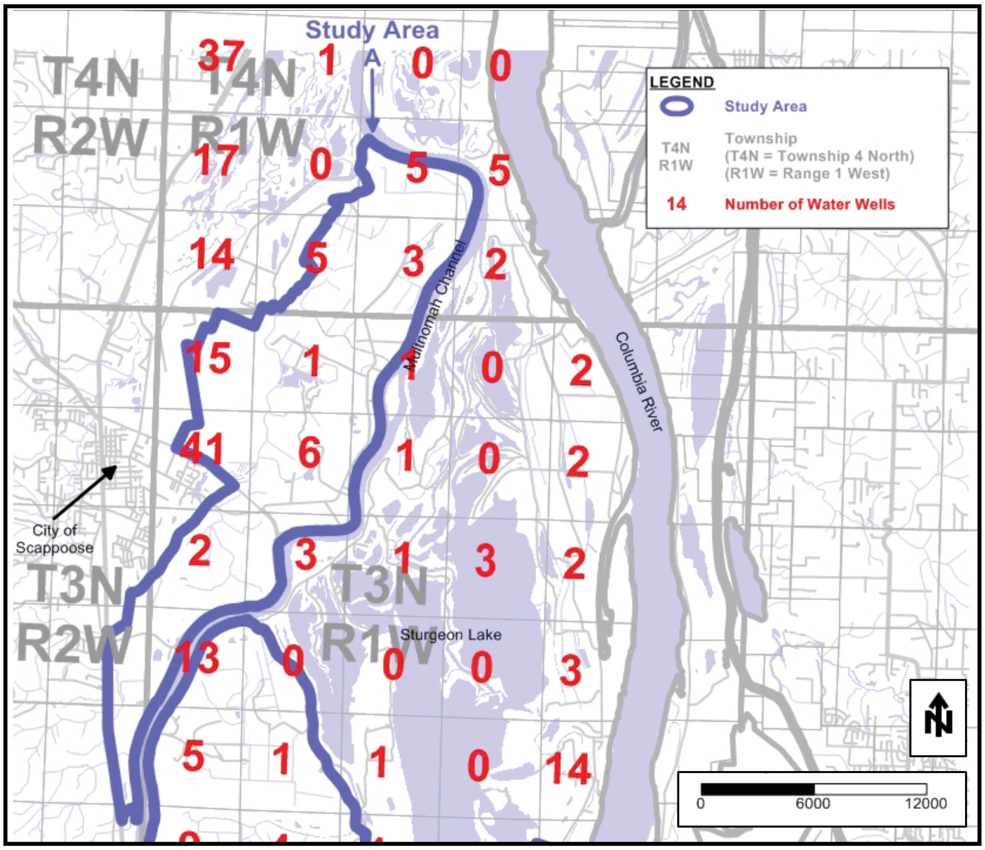


FIGURE 7
Distribution of Water Supply Wells in and Near Study Area A
City of Hillsboro Northern Groundwater Option Study

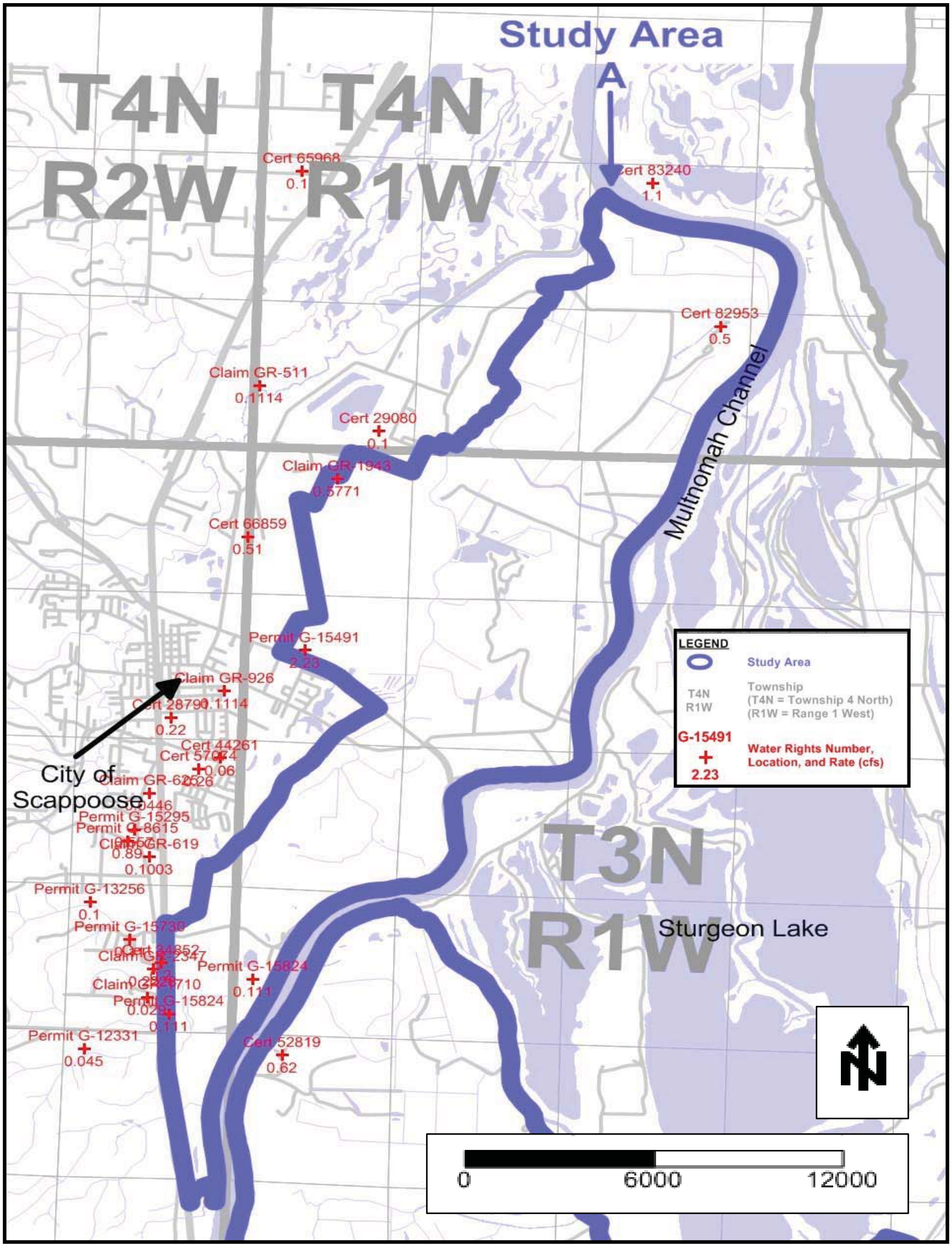


FIGURE 8
Distribution of Groundwater Rights in and Near Study Area A
City of Hillsboro Northern Groundwater Option Study

Proximity to Known Contaminant Sources

As discussed in the original hydrogeologic evaluation report (GSI, 2010), a review of public environmental databases identified 21 sites in Study Area A. These sites are mostly in the western part of the study area and are associated with fuel releases from underground storage tanks (UST) that are thought to pose a low risk if a wellfield were to be developed in the eastern portion of Study Area A.

Confirmed groundwater contamination was identified at the "Groundwater – E Columbia Avenue" site in Study Area A (site ID #8 on the map shown in Figure 9), which is at the City of Scappoose's sewage treatment plant. During decommissioning of a gasoline UST, halogenated organic compounds were detected in shallow groundwater beneath the site. Apparently, the City of Scappoose installed monitoring wells around the former tank location, but there are no available water quality data from the wells. The groundwater contamination discovered at this site poses a possible risk to deep groundwater quality in this general area because the contaminants of concern are relatively mobile, the source of contamination is unknown, and the extent of the contamination is unknown. If wellfield development is considered in the future in Study Area A, then more information should be gathered to assess potential risks to the deep groundwater system in and around this area. No other significant contamination issues in deep groundwater were identified in Study Area A during this database review.

Proximity to Roadways

Roads are present near the Multnomah Channel along much of the east side of Study Area A. Siting collector wells near these roads (including Dike Road and Honeyman Road) will facilitate the construction of conveyance piping. Additionally, this placement will be feasible wherever these wells are close to, but not directly next to, the Multnomah Channel, given that a collector's laterals should be sited at least 200 feet from the channel and other surface water bodies as discussed below.

Proximity to Surface Water

Per the rules administered by the OHA DWP for GWUDI, the water produced from a collector well completed in a sand and gravel aquifer will require filtration if the collector well's laterals lie within 200 feet of a surface water body. (See Oregon Administrative Rules [OAR] 333-061-0032(8)(a)(A).) Under this rule, surface water means all water that is open to the atmosphere and subject to surface runoff (see OAR 333-061-0020(188)). Under this definition, surface water bodies in and near Study Area A include not only the Multnomah Channel, but also streams, lakes, wetlands, and irrigation and drainage ditches. Figure 10 shows the locations of surface water bodies plus wetlands that have been identified from the National Wetlands Inventory. OHA DWP guidance indicates that if gravel aquifer wells lie farther from surface water features than the 200-foot setback requirement, then the source is classified as groundwater and is not GWUDI.

As discussed later in the water rights section of this technical memorandum, if the City were to seek a "surface water to groundwater" transfer for its water right under a collector well supply scenario, then the collector wells might need to be within 500 feet of the Multnomah Channel to meet OWRD's requirements for such a transfer. In contrast, if a new groundwater permit were to be pursued, then siting any of the collectors within 1 mile of the channel would likely trigger a review of surface water availability by OWRD and potentially result in permit conditions for protection of flows and water quality for fish species.

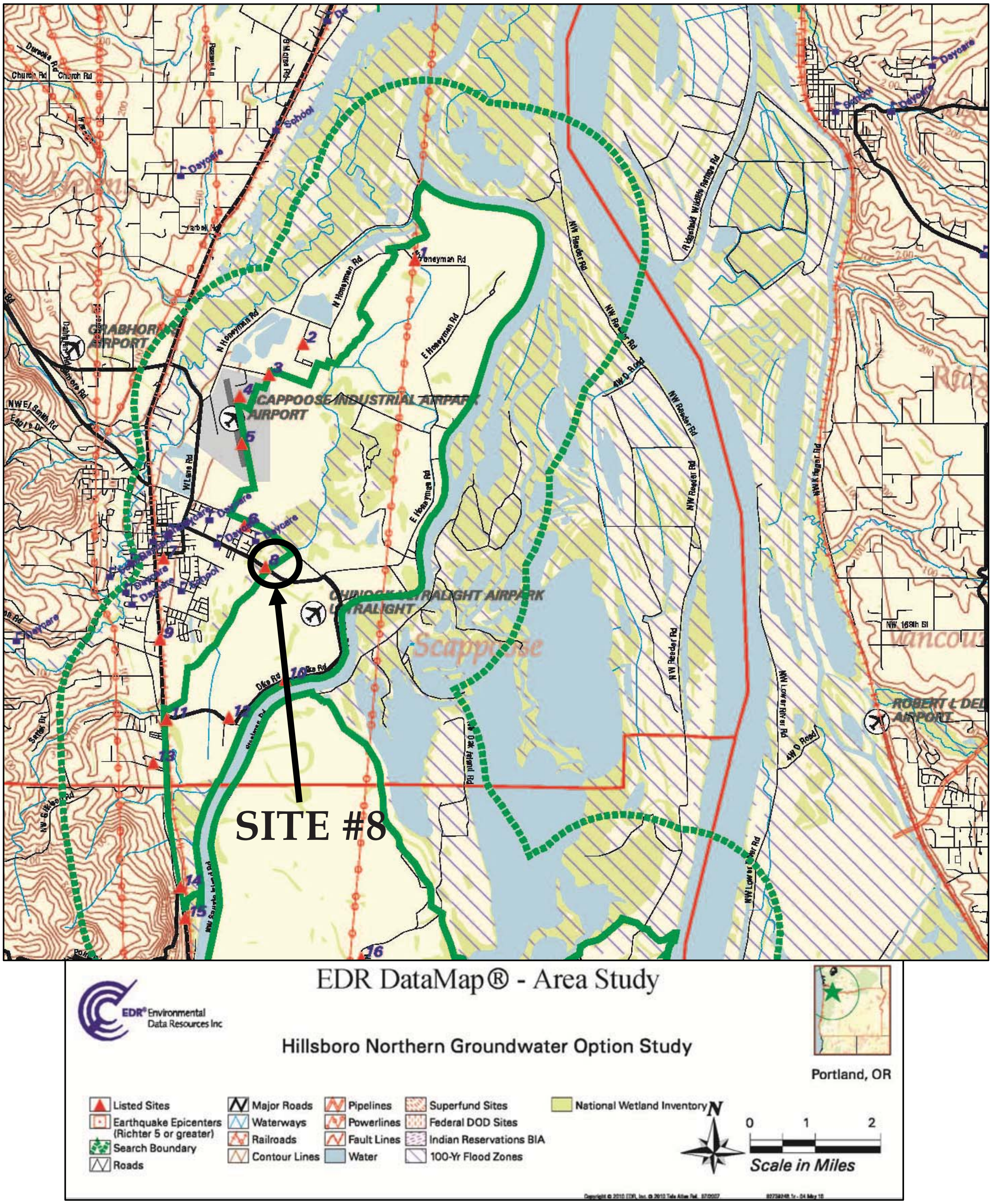


FIGURE 9
Facilities in Study Area A with Records in One or More Public Environmental Databases
City of Hillsboro Northern Groundwater Option Study

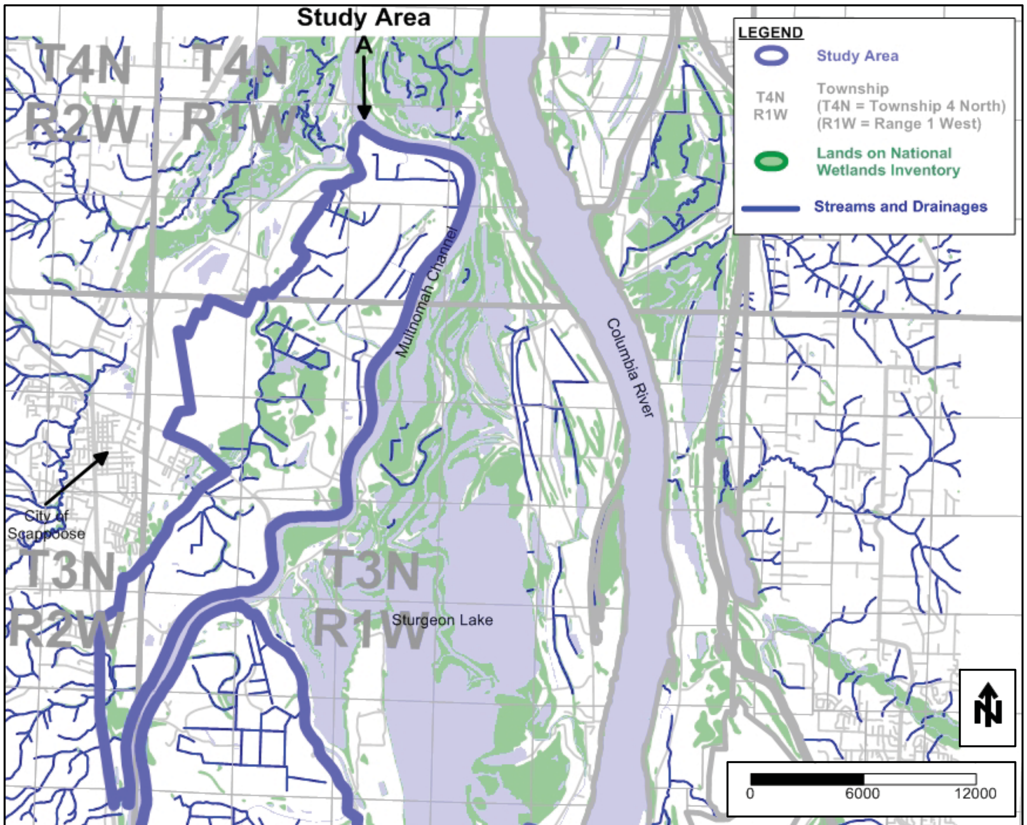


FIGURE 10
Locations of Surface Water Bodies and Wetlands
City of Hillsboro Northern Groundwater Option Study

Collector Wellfield Development Concept

A simple modeling analysis was conducted to evaluate the development potential of the gravels for a collector well scenario, and to evaluate the potential drawdown impacts to other groundwater rights under various scenarios for the pumping rates and locations of collector wells. The methods and approach for the modeling work were the same as described in Section 4.4 of the initial hydrogeologic evaluation (GSI, 2010). For a collector well scenario, the primary findings from the modeling analysis are:

1. An aquifer yield of 80 to 100 mgd is possible if a series of collector wells are placed near the eastern boundary of Study Area A along a line extending from east or southeast of the City of Scappoose northward to the northeastern corner of the study area.
2. Depending on the permeability of the gravel unit, developing 80 to 100 mgd of sustainable water supply from a collector wellfield may require the installation of as many as 8 to 10 collector wells. Additionally, these wells would likely need to be spaced near the Multnomah Channel along much of the length of Study Area A. If the permeability of the gravel unit is on the order of 1,600 feet/day, as was assumed for the original analysis of a conventional wellfield (GSI, 2010), then it is likely that each collector would pump no more than 10 mgd on a long-term basis. Higher permeability values could potentially reduce the number of collector wells required to achieve a target yield; however, while higher permeabilities are possible in the gravel unit, it is also possible that portions of the gravel unit could have lower permeability at some collector sites, in which case a given target yield might not be achievable. Because of the lack of wells (and therefore aquifer testing data) across most of Study Area A, the sustainable yields, spacing, and number of collector wells required to achieve a given production target volume are uncertain at this time.
3. For a permeability of 1,600 feet/day across Study Area A and nearby areas, an 80-mgd to 100-mgd collector wellfield could lower the water table by 15 to 25 feet across Study Area A, including at many of the locations (shown in Figure 8) of other wells that have groundwater rights in and near Study Area A. The modeling analysis indicates this amount of water table drawdown from collector well operations also would be fairly uniform throughout the City of Scappoose and nearby adjoining areas. Sensitivity analyses with the model also indicate that if the permeability of the gravel aquifer is 50 percent greater than the estimated 1,600 feet/day value, then a 100-mgd wellfield would likely have drawdown impacts of 15 feet or less throughout most of Study Area A. In contrast, an aquifer permeability that is only 2/3 of the estimated 1,600 feet/day would likely create more than 30 feet of drawdown throughout this area. As discussed in the original hydrogeologic evaluation (GSI, 2010), where drawdowns are on the order of 25 feet or more, OWRD may conclude that the project has the potential to cause injury to other groundwater users who have wells that are completed in the gravel aquifer, including not only groundwater rights holders, but also exempt (domestic) wells. In this context, injury means groundwater level declines caused by the project that result in another water user (well owner) being unable to access the full amount of water they are legally entitled to and customarily receive. In order to make an assertion of injury, OWRD would have to conclude that the affected well fully develops the aquifer (e.g., the well has to penetrate the aquifer fully).

4. The permeability of the gravel aquifer and the City's target yield for the collector wellfield together will dictate the size of the area over which collector wells will need to be installed. In particular, increasing the target yield will increase the number of collectors that will be needed and also will increase their spacing in order to minimize potential impacts to other groundwater users.
5. A recommended target area for collector well installation is shown in Figure 11. This area extends along the west side of the Multnomah Channel, from southeast of the City of Scappoose to the northeastern end of Study Area A. This area has been identified on the basis of its following characteristics:
    - The gravel aquifer is thickest in this area, whereas it thins to the west.
    - This location is farthest from existing water rights, which is necessary to maximize production from a collector wellfield while minimizing injury to other groundwater users.
    - If a water right transfer from an existing surface water right (on the Multnomah Channel) to groundwater were to be pursued by the City, then siting wells within 500 feet of the Multnomah Channel would facilitate the permitting process. However, the laterals should remain at least 200 feet from the channel to avoid a presumption of GWUDI by OHA DWP, and hence potentially the need to provide filtration of the pumped water.
6. The modeling analysis also indicates that a 100-mgd collector wellfield inside Study Area A would create drawdowns in the gravel unit of 5 or more feet throughout not only Study Area A, but much of Study Area B. This could lower the groundwater levels in the sand unit, which directly overlies the gravel aquifer, and potentially could even lower groundwater levels in the surficial silt unit. This in turn potentially could affect surface water sources, depending on the permeabilities of (1) the silt unit and (2) the sediments that form the beds of individual surface water bodies.
7. A field testing program is recommended in order to obtain local area estimates of the aquifer's permeability and yield and to estimate a long-term sustainable target yield that can be expected from a collector wellfield. A well-designed and well-executed field testing program will also provide data that can be used to design the wellfield layout and further refine the analysis of potential drawdown influences on other groundwater users in the region – an analysis that will be important for supporting a groundwater permit application or transfer.

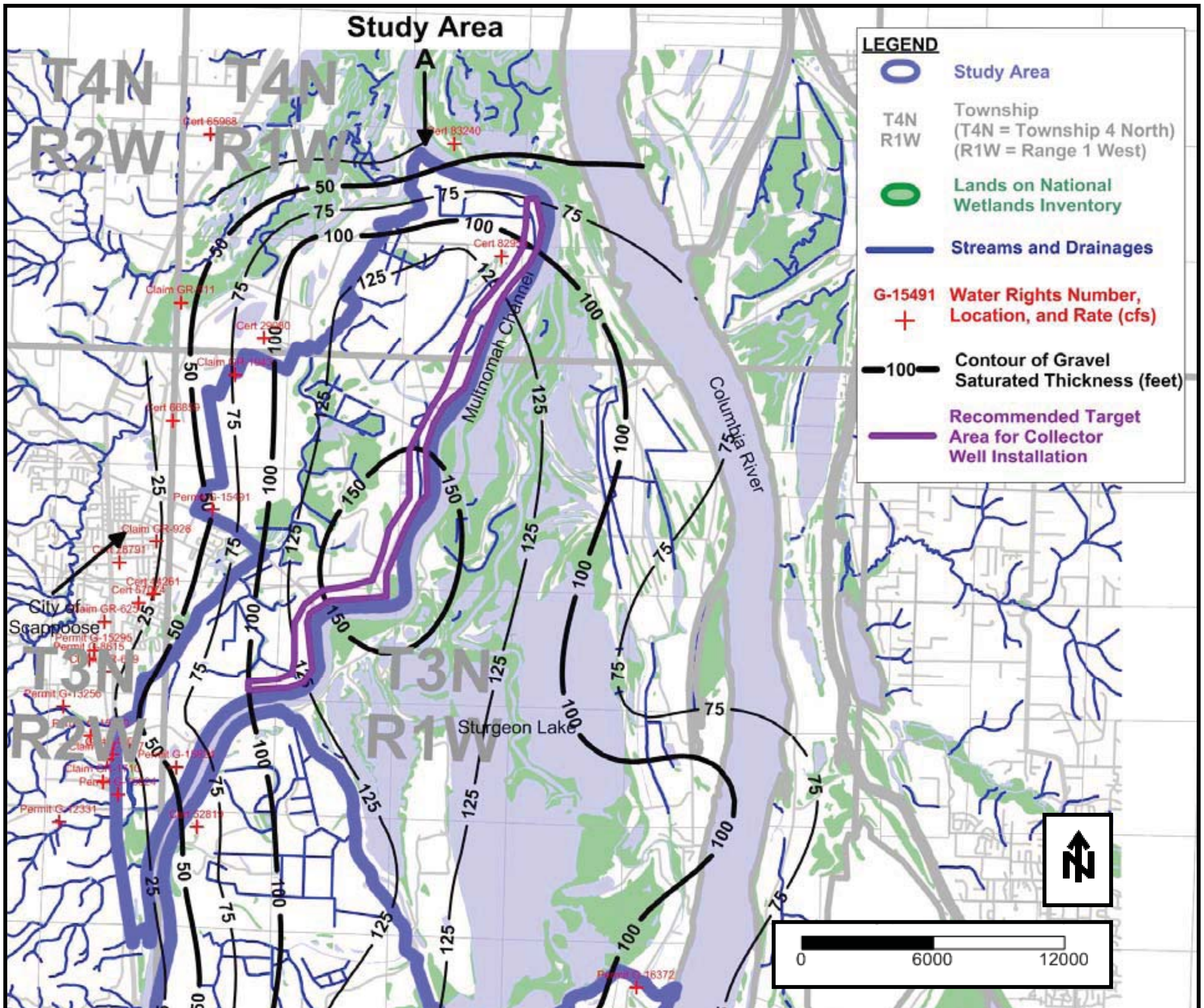


FIGURE 11
Recommended Target Area for Collector Well Installation
City of Hillsboro Northern Groundwater Option Study

Water Right Permitting Alternatives, Processes, and Potential Issues

The appropriation of water for one or more collector wells could be authorized by one of the following mechanisms (alternatives):

- Alternative 1: Obtaining a new groundwater use permit
- Alternative 2: Acquiring and transferring an existing groundwater right
- Alternative 3: Acquiring an existing surface water right and conducting a surface water to groundwater transfer

GSI's evaluation of these three alternatives for a collector wellfield is summarized in Table 1.

For a collector wellfield, the process and risks associated with Alternative 2 above (acquiring and transferring an existing groundwater right) are the same as the process and risks associated with the original Northern Groundwater Option concept that involved conventional vertical wells. The processes for acquiring and modifying an existing groundwater right are described in Section 6.2 of the January 2011 Technical Report No. 4 (GSI, 2011). In summary, OWRD would review a request to change an existing groundwater right to be used at a new point of appropriation (collector well) to determine if it would appropriate water from the same source and whether it would result in injury to existing water rights or enlargement of the original water right.

The following sections have been developed to specifically address the collector well concept for Alternatives 1 and 3 above. Specifically, the following sections describe the processes for:

- Obtaining authorization to appropriate water from collector wells by obtaining a new groundwater use permit (Alternative 1)
- Modifying an existing surface water right to allow use of groundwater, under a surface water to groundwater transfer (Alternative 3)

Alternative 1: New Groundwater Use Permit

Under this alternative, the City would obtain a new water use permit authorizing the appropriation of groundwater from collector wells in Study Area A.

Process to Obtain a New Water Right: The City would apply to the OWRD for a new water use permit authorizing the use of groundwater from collector wells for municipal purposes within its service area. OWRD reviews permit applications to determine whether there is water available for the proposed use, the proposed use is consistent with the applicable basin program rules, the proposed use would cause injury to existing water rights, and the proposed use is consistent with other rules of the Oregon Water Resources Commission.

Source Availability: GSI's assessment of the groundwater supply indicates that OWRD would determine that groundwater is available for the proposed use. Specifically, modeling analyses indicate that while some lowering of the water table could occur in Study Area A and perhaps adjoining areas, the declines would stabilize relatively quickly, and without depleting the groundwater that is present in the gravel unit. In other words, hydrogeologic conditions are such that the volume pumped from a collector wellfield would be replaced by an equal volume of recharge to the gravel aquifer. As a result, it is highly unlikely that this aquifer would experience overdraft, where pumping exceeds the rate of recharge replenishment. Additionally, during a recent (2010) review of a small water right application in Study Area B, OWRD found that groundwater was available for the proposed use in this general area.

As part of the application review process for a groundwater permit, OWRD's staff also would determine whether the groundwater source is hydraulically connected to surface water. If the source is hydraulically connected, OWRD's staff would determine if the proposed use of groundwater would have the "potential for substantial interference" (PSI) with surface water. OWRD would assume that a proposed use of hydraulically connected groundwater will have PSI if it meets any of the following criteria:

1. The well is less than ¼ mile from the surface water.
2. Water would be appropriated at a rate of more than 5 cfs and the well is less than 1 mile from the surface water.
3. Water would be appropriated at a rate more than 1 percent of the discharge rate of the stream that is expected 80 percent of the time, and the well is less than 1 mile from the surface water.
4. Groundwater appropriation for a period of 30 days would cause stream depletion more than 25 percent of the rate of appropriation, and the well is less than 1 mile from the surface water.

Whether OWRD would find that the proposed groundwater use was hydraulically connected to, and have PSI with, the Multnomah Channel will depend on the locations selected for the collector wells. (If a well is within ¼ mile of a surface water source and in an unconfined aquifer, then hydraulic connection is assumed.) If the proposed use of groundwater is determined to have PSI, OWRD then would consider limitations and restrictions associated with the hydraulically connected surface water source, including whether surface water is available for appropriation. OWRD likely would find that surface water was available; however, the agency has not conducted a water availability analysis for the Multnomah Channel and incorporated it into its online water availability database. We understand OWRD would ask the local watermaster whether water was available for the proposed use. A watermaster review was conducted in 2010 for a groundwater application in Study Area B that OWRD determined to have PSI with the Multnomah Channel. The request was for a small irrigation water right (0.111 cfs). The review indicated no concerns about water availability and recommended approval of the application with a condition requiring a totalizing flow meter at the point of diversion. While this previous review does not guarantee the same result in the future, it does provide a reasonable insight into the agency's current view of surface water availability for the Multnomah Channel, and suggests that the risk of OWRD deciding that surface water is unavailable is relatively low.

Basin Program Classification: The Willamette Basin Program rules classify the groundwater resources in the basin as allowing numerous beneficial uses, including municipal use. The only exceptions to this are in five groundwater limited areas; however, none of those areas lies within or adjacent to the Northern Groundwater Option study area. Hence, none of the exceptions would be applicable here.

If the proposed use would appropriate groundwater from unconfined alluvium within ¼ mile from a surface water source (which is likely under the collector well concept), the use also would be required to be consistent with the surface water classifications in the Willamette Basin

Program. The basin program classifications for surface water, however, would not impede such a groundwater application. The basin program rules for the Columbia Subbasin classify surface water in this portion of the Willamette River and Multnomah Channel for municipal purposes.

Impact on Existing Water Rights: The proposed use may cause some interference with existing groundwater or surface water rights in the area. The magnitude of this interference would depend on the aquifer's water-bearing capability, the amount of the City's groundwater appropriation, and the proximity of the collector wells to existing wells owned by other water rights holders. Modeling work described previously in this technical memorandum indicates that if sufficient drawdown arises to cause injury to the nearest groundwater users, then drawdowns of similar magnitude could occur over a fairly broad area within and around the City of Scappoose and thus affect a large number of the groundwater users in the area in and west of Study Area A.

If OWRD found that the proposed use would have PSI with surface water in the Multnomah Channel, the effects on existing surface water rights would be considered as part of assessing surface water availability, as previously described in the discussion of groundwater source availability.

Conditions: Proposed uses of groundwater determined to have PSI with surface water undergo a "Division 33" additional public interest review process as if the application were for the use of surface water (OAR Chapter 690, Division 33). As part of the Division 33 review, both the Oregon Department of Fish and Wildlife (ODFW) and the Oregon Department of Environmental Quality (DEQ) provide comments on water right applications. These agencies can recommend denial of applications or conditions limiting the use of water to protect flows and water quality for listed fish species.

If the proposed groundwater use were determined to have PSI with the Multnomah Channel, it is unclear what, if any, conditions ODFW or DEQ would recommend. A surface water permit (S-54252) issued in March 2006 did not include conditions to protect fish, but did include a condition to protect water quality to meet state and federal standards. The limited conditioning of the 2006 permit does not, however, necessarily predict how a new permit application would be conditioned.

If ODFW determined that the new groundwater right should be conditioned to protect listed fish species, it is not entirely clear whether the agency would apply flow targets for the Willamette River or the Columbia River, or another standard. The following discussion provides our analysis of flow conditions for the Willamette and Columbia Rivers.

- **Willamette River.** ODFW's recommended fish flow targets for the Willamette River, as well as statistics about the frequency with which these conditions are met, were described in detail in Section 2.1 of Technical Report No. 4 (GSI, 2011; see pages 4-7). As discussed in that report, flows in the Willamette River during a 35-year period were often insufficient to meet ODFW's target flows during the spring high-flow period (generally from April through June). The target flows in July through October, however, appear to be less problematic. Although the U.S. Army Corps of Engineers (USACE) has managed the federal storage projects to meet these target flows during the last several years, there is no guarantee that the USACE will continue to manage its reservoirs in a manner that would allow the target flows to be met.

- **Columbia River.** We are aware that ODFW is concerned about protecting chum salmon spawning areas on the Columbia River, but this area is upstream from the Multnomah Channel. The flow targets for the Columbia River and the frequency that the targets are not met were described in detail in Section 6.1 of Technical Report No. 4 (GSI, 2011; see pages 24-27). As discussed in that report, our review of the Columbia River flows indicates that fish flow targets are frequently not met most days during the period from May through September.

If the City has interest in proceeding with the collector well option, more work would need to be conducted to evaluate public interest issues with the Multnomah Channel.

Reliability: As discussed previously, the hydrogeologic setting is such that the gravel aquifer will be replenished by recharge that is induced by pumping from one or more collector wells. As a result, the aquifer is highly unlikely to experience overdraft as a result of collector well development in Study Area A. However, the proposed use may cause some interference with existing groundwater or surface water rights in the area. The magnitude of this interference would depend on the amount of the City's groundwater appropriation and the proximity of the collector wells to existing groundwater users.

The reliability of the water right could be affected by minimum fish flow targets in the Willamette or Columbia Rivers, if ODFW were to request that the groundwater right be conditioned to protect listed fish species in one of these river systems. If the permit were to contain such a condition, then curtailment of pumping from the collector wells could be required during the months that the minimum fish flow targets are not met in the applicable river system.

Risk: As described in Technical Report No. 4 (GSI, 2011), OWRD allows third parties to file protests to new water right applications. A third party could file a protest based on concerns about impacts to surface water, or concerns about excessive interference or injury.

Another risk is that the resulting permit could potentially be heavily conditioned. The conditions could reduce the City's access to water during certain months of the year if the use were determined to have PSI with surface water and would affect listed fish species.

Timeline: The water right application process typically takes 1 year to complete, if a protest is not filed. If a protest is filed, the process could take 2 to 5 years.

Other Issues: As a municipality, the City is not required to obtain authorization or an easement to locate collector wells on particular property before obtaining a water right. (Because a water right does not grant access to property, the City ultimately would need authorization to locate collector wells on private property.)

Alternative 3: Acquire an Existing Surface Water Right (Surface Water to Groundwater Transfer)

Under this alternative, the City would obtain an existing surface water right (either a certificate or a municipal permit) and modify it to allow appropriation from collector wells.

Process for Surface Water to Groundwater Transfer: The surface water to groundwater transfer process provides the ability to change a surface water right to allow the water right holder to appropriate water from a well. To approve such a transfer, OWRD must determine that (1) the well would appropriate water from an aquifer that is hydraulically connected to the authorized surface water source associated with the original right, and (2) that the change would not result in injury to other water rights or enlargement of the original right. Further, the well may need to be within specified distances from the stream and the original point of diversion.[1] Finally, OWRD would need to find that the proposed change would affect the surface water source "similarly"[2] to the authorized point of diversion identified in the water right.

Source Availability: The applicable statute and rules require the aquifer in question to be hydraulically connected to "the authorized surface source." The agency may interpret this requirement to mean that the surface water source affected by the groundwater use must be the source identified on the surface water right. OWRD could, however, interpret this provision more broadly and allow surface water to groundwater transfers of surface water rights authorizing the use of upstream tributaries. While there are municipal permits and water right certificates on the Willamette River, upstream from the Multnomah Channel, transferring these rights to the collector wells could be difficult because diversions from the collector wells would need to affect the source "similarly" to the point of diversion identified in the water right. Consequently, if the collector wells are hydraulically connected to the Multnomah Channel, then the surface water right to be transferred likely will need to identify its source as "the Multnomah Channel."

GSI queried OWRD's water rights information system and point of diversion databases for water rights that authorize the use of water from a point of diversion on the Multnomah Channel. Table 2 shows seven Multnomah Channel certificates that were identified as authorizing diversion from the Multnomah Channel. (No municipal water use permits were identified with points of diversion on the Multnomah Channel.) Two water right certificates (Certificates 49880 and 85053) authorize the use of 40 cfs or more. Certificate 49880, which is held by the Sauvie Island Drainage District, has multiple points of diversion along the outer boundaries of Study Area B. The point of diversion for Certificate 85083 is located just above the mouth of the Multnomah Channel, at the Boise Cascade Paper Mill in St. Helens.

It should be noted that the status of one of these certificates (Certificate 49880, which is for 63.54 cfs, or 28,517 gpm) is not known. This water right certificate would need to be evaluated for forfeiture resulting from non-use. In contrast, Certificate 85053 (which is for 65.00 cfs, or 29,172 gpm) cannot be subject to cancellation for forfeiture at this time because it has been less than 5 years since the date of certificate issuance (December 12, 2008).

Impact on Existing Water Rights: The impact on existing water rights comes into play when OWRD evaluates the potential for injury during its review of the transfer. Generally, moving a point of diversion downstream does not cause injury. Moving a point of diversion upstream typically requires a more thorough injury analysis. In this situation, if OWRD determined that the collector wells were "upstream" from the surface water right's point of diversion, the agency likely would find that the move would not cause injury because water is available to meet existing rights and there is no instream water right on the Multnomah Channel.

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[1] OWRD requires that the well be within 500 feet from the surface water source and within 1,000 feet up or down stream from the original point of diversion. If the well location does not meet these requirements, the applicant can provide evidence that the transfer would, nonetheless, meet the other criteria.

[2] OWRD would require the use of groundwater at the new point of diversion to affect the surface water source identified in the water right and result in stream depletion of at least 50 percent of the rate of appropriation within 10 days of continuous pumping.

Conditions: Any existing conditions on the water right and any associated extension order would remain with the water right following the transfer or permit amendment process. For example, Certificate 85053 requires annual submission to OWRD of monthly water use records.

In addition to the existing conditions, as part of the transfer process OWRD would include a condition stating that the amount of water that could be diverted at the new point of diversion would be limited to the amount available at the original point of diversion.

Reliability: The reliability of a water right depends on its priority date, the conditions on the water right, and whether flow limitations exist at the original point of diversion. No flow limitations are expected to exist on the Multnomah Channel, and neither of the existing large water rights contains conditions that are anticipated to affect the reliability of the right. Consequently, both of the large water rights (Certificates 49880 and 85053) are expected to be reliable. If other water rights are considered for transfer, then the reliability of those rights also will need to be evaluated.

Risks: There are several risks with this option. First, a third party could file a protest, but protests are limited to addressing whether the transfer would cause injury. As a result, protests to transfer applications are relatively rare, and the risk in this case is low. Additionally, OWRD could find that the proposed change in the point of diversion will not affect the Multnomah Channel "similarly" to the authorized point of diversion and thus deny the transfer application. Further, during the 5-year period following approval of a "surface water to groundwater" transfer, OWRD can subordinate the right to an existing groundwater right that experiences "substantial or undue interference"[3] as a result of the transfer, regardless of the priority date on the affected existing groundwater right.

Timeline: The timeline for OWRD to process and approve a transfer application would be approximately 8 months to 1 year. If the new points of appropriation (collector wells) are located more than 1,000 feet upstream or downstream from the original point of diversion, then a licensed geologist would need to prepare evidence for OWRD demonstrating that the new points of appropriation would affect the Multnomah Channel "similarly," as defined by rule. This need for document development would extend the time frame for development and processing of the transfer application.

Other Issues: To implement this option, the City would need to find a willing seller or partner. The City would need to negotiate a memorandum of understanding or other agreement to document the transaction. The parties also would need to negotiate a mutually acceptable price.

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[3] OAR 690-008-0001(8) defines "substantial or undue interference" to mean:

> The spreading of the cone of depression of a well to intersect a surface water body or another well, or the reduction of the ground water gradient and flow as a result of pumping, which contributes to:
> (a) A reduction in surface water availability to an extent that:
> (A) One or more senior surface water appropriators are unable to use either their permitted or customary quantity of water, whichever is less; or
> (B) An adopted minimum streamflow or instream water right with an effective date senior to the causative ground water appropriation(s) cannot be satisfied.
> (b) The ground water level being drawn down to the economic level of the senior appropriator(s); or
> (c) One or more of the senior ground water appropriators being unable to obtain either the permitted or the customary quantity of ground water, whichever is less, from a reasonably efficient well that fully penetrates the aquifer where the aquifer is relatively uniformly permeable. However, in aquifers where flow is predominantly through fractures, full penetration may not be required as a condition of substantial or undue interference.

References Cited

GSI Water Solutions, Inc. (GSI). 2010. *Final Draft Report: Hydrogeologic Evaluation of the Northern Groundwater Supply Option.* Prepared for City of Hillsboro Water Supply Alternatives Project. June 2010.

GSI Water Solutions, Inc. (GSI). 2011. *Draft Report: Water Rights Review of Water Supply Options (Technical Report No. 4)*. Prepared for City of Hillsboro Water Supply Alternatives Project. January 2011.

Alternative	Water Right Process	Source Availability	Existing Water Rights	Conditions	Reliability	Risks	Timelines for Water Right Process	Other Issues
Northern Groundwater Option (NGO)								
1. New Groundwater Use Permit	Water right application	50 to 100+ mgd of groundwater available	Interference to existing groundwater rights could occur; magnitude depends on amount of appropriation and aquifer permeability	If found to have potential for substantial interference with surface water, would expect conditions to protect surface water flows. Conditions would depend on whether affecting Columbia R. or Multnomah Channel.	Reliability dependent on conditions Conditions to protect fish flows on Columbia River could significantly reduce reliability	Third party protests possible	1 year (without protest) If a protest is filed—2 to 5 years	None identified at this time
2. Acquire Existing Groundwater Right	Transfer application	21 groundwater certificates in and around the NGO study area	Interference to existing groundwater rights could occur; magnitude depends on amount of appropriation and aquifer permeability	No additional conditions beyond those in existing right	Reliability dependent on original certificate	Third party protests possible	8 months to 1 year	Need to find a willing seller and agree on price
	Permit amendment for municipal use permit	4 groundwater permits for municipal use in and around the NGO study area	Interference to existing groundwater rights could occur; magnitude depends on amount of appropriation and aquifer permeability	No additional conditions beyond those in existing right, including extensions	Reliability dependent on original permit	OWRD could interpret the regulations differently and deny application Could be difficult to obtain certificate at new place of use in the future	6 to 8 months	Identify whether Port of Portland and/or City of Scappoose would be seller or partner Negotiate contract and cost
3. Acquire Existing Surface Water Right	Surface water to groundwater transfer	Two Multnomah Channel certificates greater than 40 cubic feet per second (cfs)	Interference to existing groundwater rights could occur; magnitude depends on amount of appropriation and aquifer permeability	No additional conditions beyond those in existing right	Relatively reliable – dependent on original right	Third party protests possible OWRD could find proposed use does not affect surface water "similarly" Right could be subordinated to injured groundwater right during the first 5 years due to substantial or undue interference	8 months to 1 year Additional time may be required if wells not within specified distance from authorized point of diversion	Identify willing seller or partner Negotiate MOU

DRAFT Table 2

Identified Surface Water Rights on Multnomah Channel

City of Hillsboro Northern Groundwater Option Study

April 2011

DocumentName	Stakeholder	Uses	Source	TributaryTo	MaxRateCfs
Cert: 48756 *	ALDER CREEK LUMBER CO. INC.	FP	MULTNOMAH CHANNEL	COLUMBIA RIVER	0.50
Cert: 85053	BOISE WHITE PAPER LLC	IM	MULTNOMAH CHANNEL	COLUMBIA RIVER	65.00
Cert: 42704	WALLACE JOHNSON	IR	MULTNOMAH CHANNEL	COLUMBIA RIVER	1.47
Cert: 49880	SAUVIE ISLAND DRAINAGE DISTRICT	IR	MULTNOMAH CHANNEL	COLUMBIA RIVER	63.54
Cert: 86317	MARQUAM FARMS CORP	IR, IS, WI	MULTNOMAH CHANNEL	COLUMBIA RIVER	2.88
Cert: 57166	JAMES ERNEST	IR	MULTNOMAH CHANNEL	COLUMBIA RIVER	1.01
Cert: 72368	DAVID A FAZIO	IR	MULTNOMAH CHANNEL	COLUMBIA RIVER	0.03

FP = fire protection
IM = industrial/manufacturing
IR = irrigation
IS = irrigation (supplemental)
WI = wildlife

APPENDIX D

Abbreviations List

APPENDIX D
Technical Memorandum 08
Summary of Water Supply Development Options

ABBREVIATIONS LIST

The following is a list of abbreviations used in TM 08.

ASR	Aquifer Storage and Recovery
B&V	Black & Veatch
City	City of Hillsboro
CWS	Clean Water Services
GSI	Groundwater Solutions Incorporated
JWC	Joint Water Commission
M&I	Municipal & Industrial
MDD	Maximum Day Demand
MG	Million Gallons
MGD	Million Gallons per Day
MWH	Montgomery Watson Harza
NGSO	Northern Groundwater Supply Option
PUD	Public Utility Department
PWB	Portland Water Bureau
TAC	Technical Advisory Committee
TBWSP	Tualatin Basin Water Supply Project
TM	Technical Memorandum
TVID	Tualatin Valley Irrigation District
WCSL	Washington County Supply Line
WRWTP	Willamette River Water Treatment Plant
WTP	Water Treatment Plant