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Guidance for the Preparation of Hydrogeologic Review Reports

Clackamas County

Zoning and Development Ordinance

Section 1006

Prepared by

Clackamas County Department of Transportation and Development

Strategic Planning and Sustainability Division

AMEC Earth & Environmental, Inc.

July 2019

150 Beavercreek Road, Oregon City, OR 97045; Phone: 503 742-4500; Fax: 503-742-4550

Hydrogeologic Review Report Manual

INTRODUCTION

On May 20, 2010 the Clackamas County Board of County Commissioners (BCC) approved and adopted amendments to Section 1006 of the Clackamas County Zoning and Development Ordinance (ZDO). These amendments address water supply standards outside the Portland Metropolitan Urban Growth Boundary (PMUGB) in unincorporated areas of Clackamas County and the Mount Hood Urban Area as they pertain to certain developments that propose to utilize exempt use wells (see Applicability section below). Section 1006 is provided as Exhibit A in this manual.

The effective date of these ordinance amendments is August 18, 2010. This manual is to serve as a guide only and to assist in the preparation of a Hydrogeologic Review Report in conjunction with the adopted ordinance amendments as required under Section 1006 of the Clackamas County ZDO.

Pursuant to Section 1006 of the Clackamas County ZDO, a Hydrogeologic Review Report is required for certain, specific land divisions and certain types of development that propose to utilize exempt-use wells outside of the PMUGB. Applicants that propose certain development types are required to submit evidence in conjunction with the land use permit application that the long-term sustainability of groundwater resources in the vicinity of the new land use is reasonably assured.

PURPOSE

Clackamas County provides this manual with the intent to provide a clear set of guidelines for state registered geologists and engineering geologists, hired by land use applicants, to comply with those requirements in Section 1006 of the ZDO for the completion of all required analysis and reports. This manual may be revised as additional hydrogeologic data becomes available, additional guidelines are developed, or as state law mandates.

APPLICABILITY

This manual applies to the unincorporated areas of Clackamas County outside the PMUGB and the Mt. Hood Urban Area (addressed in Subsection 1006.03(F) of the ZDO). The requirements of Section 1006 of the ZDO will affect the following types of land uses/developments proposing to use an exempt well or wells for potable and fire flow water supply:

1. All proposed subdivisions (land divisions resulting in four or more lots); and
2. All proposed residential land divisions (partitions and subdivisions) and all proposed new commercial, industrial, and institutional development located outside a PMUGB and inside an area that has been identified as a "Sensitive Groundwater Area" (SGA). An SGA is an area classified by the State of Oregon (State) as a groundwater limited area, critical groundwater area, or other area where new groundwater appropriations are restricted by the State. The Oregon Water Resources Department (OWRD) designated Groundwater Restricted Areas (Limited, Critical, and Withdrawn) within the State are shown on the attached Figure 1. Four groundwater limited areas are recognized within Clackamas County: Damascus, Sandy-Boring, Sherwood-Wilsonville, and Gladtidings (shown on the attached Figure 2).

LIMITATIONS

Compliance with all the elements described in this manual should not be considered sufficient to satisfy the needs for complete, accurate information in all cases. ***This manual is a guide only.*** Professional judgment may dictate that additional information is required to comply with Section 1006 of the Clackamas County ZDO by demonstrating that the subject aquifer and surrounding senior (existing) wells will not be unreasonably impacted by the proposed new development.

Additionally, this manual is not intended to provide direction on how to conduct specific tests, but to specify what information is deemed necessary to demonstrate compliance with Section 1006.

PRE-APPLICATION CONFERENCES

A pre-application conference is strongly recommended for all land divisions and other proposed development requiring a Hydrogeologic Review Report under Section 1006. It is advisable that the applicant's hired geologist or engineering geologist be present to discuss with staff the type of information that should be included in the Hydrogeologic Review Report. The county strongly recommends that applicants apply for the pre-application conference prior to beginning the Hydrogeologic Review Report so that the applicant and the hired consultant have a clear understanding of the required materials necessary to produce the Report.

HYDROGEOLOGIC REVIEW REPORT ANALYSIS

Pursuant to Subsection 1006.03(F)(2) the Hydrogeologic Review Report shall include information that affirmatively demonstrates that:

1. The aquifer is capable of sustaining the proposed development with sufficient potable water.
2. The proposed development is not likely to unreasonably interfere with existing wells, groundwater rights, and/or surface water rights. Note that surface water is not addressed explicitly in the ordinance but may be a consideration during the Hydrogeology Review if available data indicates groundwater is under the influence of surface water or vice versa; and
3. The proposed development is not likely to contribute to the overdraft of the affected aquifer.

Subsection 1006.03(F) of the ZDO defines when a Hydrogeologic Review Report is required and the scope of information that may be necessary to include in the report. The location of the subject parcel will determine the necessary scope of analysis to include in the Hydrogeologic Review Report. Lands outside the PMUGB and the SGA will require a Hydrogeologic Review Report only for subdivisions that propose to use exempt-use wells. Lands outside the PMUGB and *within* the SGA will require a Hydrogeologic Review Report for all *land divisions, new industrial, commercial and institutional developments,* pursuant to Subsection 1006.03(F)(2), that propose to use exempt-use wells.

A Hydrogeologic Review Report is an in-depth professional analysis that determines the availability of groundwater intended to supply the proposed development (see Section 1006.03(F)(3)). The Report depends on careful collection and expert interpretation of existing information (section below) such as driller's well reports, previous studies, and geologic maps. Collection of new information may be required to demonstrate compliance with Subsection 1006.03(F)(2). Because the circumstances at each proposed development site vary, the ordinance relies upon the professional completing the Report to design methods of investigation using generally-accepted methods that are pertinent to the demonstration required by 1006.03(F)(2). Some guidance is provided, but the ordinance provides flexibility to contend with unique situations.

If existing information proves inadequate to demonstrate compliance with Subsection 1006.03(F)(2), then new information shall be produced by the applicant's geologist or engineering geologist. The new information must provide adequate information and sound conclusions that determine if the proposed development will or will not result in unsustainable use of the groundwater resource. Therefore, it is strongly advised that the professional performing the analysis determine early on ALL necessary data calculations, analysis, and site specific information necessary to ensure compliance with Subsection 1006.03(F)(2) of the Clackamas County ZDO. Meeting/conference attendance with Clackamas County also is credited against the application fee.

EXISTING INFORMATION

The consulting geologist must review existing, publicly available information and report the findings and conclusions from earlier work in the vicinity of the subject site (or in other areas with similar geologic characteristics).
This review is to include publically available information regarding the specific site and surrounding study area as defined in Subsection 1006.03(F)(3)(a), such as:

- Site location vicinity, including all lots, parcels, and wells located within at least one-quarter mile of the proposed development;

- Geologic and topographic mapping;
- Estimated use of groundwater within the study area;
- Quantity of water use by the proposed development;
- Proposed target aquifer for the proposed development;
  Identification of affected aquifers;
- Compilation and review of existing geologic and hydrogeologic studies, well deepenings, and well replacements;
- Compilation and analysis of existing available geologic information, water level, and pump test
- information including evaluation of long-term stability and sustainability of groundwater levels;
- Evaluation of local stratigraphy and geologic structure;
- Estimates of the water balance within the study area;
- Proximity and potential for communication with nearby surface water features;
- Typical groundwater yield from aquifers in the study area;
  Evaluation of groundwater levels for long-term stability, and;
  Geologic and hydrogeologic maps and cross sections.

The text of the Hydrogeology Review Report can include a general summary of this research, but it should explain how the existing information relates to the circumstances of the subject site.
If the existing information is inadequate to demonstrate compliance with Subsection 1006.03(F)(2), then new information will need to be produced by the applicant's geologist or engineering geologist to comply with Subsection 1006.03(F)(2).

NEW INFORMATION

When existing information proves inadequate to demonstrate compliance with Subsection 1006.03(F)(2), new information may be necessary to address:

1. Identification of the Target aquifer(s)
2. Characterization of the aquifer properties
3. Estimation of use from the target aquifer(s)
4. Well interference
5. Potential for interaction with nearby surface water features
6. Aquifer sustainability.

The Hydrogeologic Review Report shall make professional conclusions regarding the long-term sustainability of groundwater supply.

SUBMITTAL MATERIALS

The sections below (study area, maps, tabular well data, cross sections, water level analysis, water use inventory and analysis, and aquifer sustainability) address the types of data and analyses that should be included in the report.

STUDY AREA

Subsection 1006.03(F)(3)(a) requires that the study area extend "at least one-quarter mile" from the *boundary* of the proposed development and shall include the entirety of lots bisected by the one-quarter mile radius line. The study area should be enlarged when:

1. large-volume permitted wells are located within one-half mile *of the property boundary* (or farther if professional judgment indicates it is warranted);

2. wells identified that have been anecdotally implicated as causing aquifer interference or decline, or regional water-level decline;

3. homogeneous development (i.e., include all of a subdivision, rather than letting the study area boundary bisect a development); and

4. hydrogeologic boundaries (if known) that could significantly influence groundwater movement (e.g., faults**,** changes in aquifers).

In addition, the study area may be enlarged and/or shifted to include areas underlain by the target aquifer when a portion of the original study area is underlain by a non-target aquifer.

The acreage in the study area is used to compile the water-use inventory; this acreage must include the entire study area, including the full acreage of lots wholly or partially within the one-quarter mile radius line, not just the area within the circle.

MAPS

All maps should fit onto an 8.5- by 11-inch sheet and include a scale (preferably a bar style), a north arrow, and a legend that describes all symbols used. The report should include the following maps at minimum:

1. County assessor map(s), showing all property ownership boundaries within the study area. This map should include the location of the proposed parcel(s), the ¼-mile radius around the boundary of the proposed parcel(s), the perimeter of the study area, and tax lot boundaries. (An example of a map showing all property ownership boundaries within the study area is provided as attached Figure 3);

2. United States Geological Survey (USGS) quadrangle maps showing the study area (example of a USGS quad map showing the study area with selected wells and cross section locations is provided as attached Figure 4);

3. Surface geology (An example of a map showing the surface geology is provided as attached Figure 5);

4. A map showing the locations of all known wells within the study area which have been correlated to specific tax lots according to information provided on available well logs. The county assessor map, or equivalent, may be used as the base for this map (An example of a map showing well locations is provided as attached Figure 6). The map should differentiate field-located wells (reasonably accurate locations) from assumed locations based upon correlations with tax lot numbers; and

5. A map showing groundwater water rights and the associated points of appropriation which are located within the study area, or are otherwise discussed in the report (An example of a map showing groundwater rights is provided as attached Figure 7). The map should also indicate the location of nearby surface water features within the study area and existing surface water rights.

Note the examples of maps provided in this manual are intended for illustration purposes and do not necessarily reflect actual geologic and/or hydrogeologic conditions. The maps listed above do not necessarily need to be submitted separately. Two or more maps may be combined if the resultant single map includes all of the required information and is readable and readily understandable.

The applicant's property and study area (not just a one-quarter mile radius perimeter) should be clearly outlined on each map. If the study area does not follow the boundary of the lots within the one-quarter mile study area, explain why it differs.

All located wells within the study area, labeled with a unique identification number (preferably the OWRD well log number), must be shown on a map which includes tax lot boundaries (i.e. tax assessor's map or equivalent). The same well identification number used on the map should also be used on any other maps showing well locations, cross-sections and in tables and text where the wells are identified and discussed in the report. At a minimum, the wells used for the cross sections (discussed below) and those discussed in the report need to be shown on the quad. The text of the report needs to explain the method used for determining well locations and elevations.

Although the County recognizes that adequate information to identify precise well locations is not always available, a reasonable attempt to locate wells should be made. All wells with a state water right permit

must be shown on a map, and the report should identify the source of the information (e.g., field ID, other reports). Wells used for cross-sections need to be accurately located and identified on the map.

TABULAR WELL DATA

Include a table of located wells with the following information:

1. OWRD well log identification number (e.g., CLAC99999);
2. Identification number used on topographic map (if different than OWRD's);
3. Latitude and Longitude to 5 decimal places, if field located
4. Township, range, section, quarter section (160 acres), and quarter-quarter section (40 acres), and tax map and lot number (if available);
5. Owner's name;
6. Address of well location (not necessarily the same as the address on the well report);
7. Approximate elevation of the wellhead of the wells discussed in the report and an estimated elevation error (e.g. +- 10 ft) (the text of the report needs to explain how elevations were determined);
8. Dates of original drilling and any deepening(s);
9. Depth originally drilled and any deepening(s);
10. Depth to water and date measured;
11. Primary aquifer (e.g., Columbia River Basalt); and
12. Yield
13. A detailed and factual account documented by data shall be provided to explain why a well was deepened, repaired, or replaced; and
14. Well use (i.e. domestic, irrigation, etc.)

All data regarding depth to water and yield (including any more recent than that contained on the well report) and the date measured should be included. The well data should be organized in some logical format that is explained in a footnote to the table. The same organizational method for listing the wells should be used throughout the document. A sample table is provided as attached Table 1. Available groundwater level and/or well yield data also may be displayed on a map.

If the consulting geologist has access to the OWRD GRID system, a printout of wells from that source should be included.

It would be beneficial if the consultant can provide the well data table in digital form, preferably in ASCII comma-delimited or other generic format, on a CD.

CROSS SECTIONS

Pursuant to Subsection 1006.03(F)(3)(a) geologic cross sections shall include representative wells and shall show stratigraphy, subsurface structure, and water-bearing zones that will be developed by the proposed land division. Reasonable efforts should be made to include all well deepenings and permitted wells on cross sections. Include horizontal and vertical bar scales. In addition, cross-sections should show:

1. surface elevation;

2. the screened or open interval in the wells;

3. water level data and date(s) measured;

4. well deepening information;

5. stratigraphy;

6. GRID well-identification number; and

7. unique well identification number, if different from the GRID number.

An example of a cross section is provided as attached Figure 8. Note examples provided here are intended for illustration purposes only and do not necessarily reflect actual geologic and/or hydrogeologic conditions.

WATER LEVEL ANALYSIS

The report shall determine whether existing water-level data is sufficient to characterize the sustainability of the aquifer. Decadal precipitation trends should be taken into account when appropriate. The water level analysis must employ a generally accepted method that is:

1. Applicable to, and incorporates the effects of, the hydrogeologic conditions in the study area; and

2. Fully employs existing water-level data.

3. The report must clearly document the sources of data, assumptions, and limitations of methods used.

WATER USE INVENTORY AND ANALYSIS

A water use inventory shall be compiled to estimate current and potential use for all existing lots that produce from the aquifers of interest. The water use inventory shall be discussed within the context of all other factors to help determine compliance with 1006.03(F)(2). The inventory shall include all of the following elements:

1. Non-exempt use in the study area. All sources of information on non-exempt uses available from the Oregon Water Resources Department (including the interactive mapping program, GIS database, and plat card reports) must be reviewed to identify all groundwater rights within and surrounding the study area (the GIS database and interactive mapping program are sometimes not updated as often as the plat card reports). For irrigation wells, annual use of 1.5 feet per acre may be assumed for primary irrigation and one foot per acre for supplemental irrigation. The consultant should explain the calculated consumption for other permitted uses. Water use from irrigation or commercial wells that obtain water from multiple water bearing zones can be prorated according to the yield predicted from the water bearing zones that are also developed for exempt use;

2. Small lots that may not be developable (buildable) must be reviewed by Clackamas County for buildability before they can be excluded from the water balance calculations; and

3. All existing lots and parcels and new lots proposed for the subject property at a rate of 400 gallons per day for household use and 2,000 gallons per day for lawn and landscape irrigation from June through September (See Subsection 1006.03(F)(3)(a)(iii) and (iv)).

4. Areas that are illegally irrigated without a water right should not be included in the water balance calculation but should be addressed as anecdotal information;

5. A copy of a cancellation notice, stamped received by the Oregon Water Resources Department, together with other supporting evidence, can be used as proof that a water right is subject to

cancellation and should not be included in the water balance calculations.

The Water Resources Department provides the following conversion rates in "Water Rights in Oregon" (1997):

1 cubic foot/second =	7.48 gallons/second
	448.8 gallons/minute
	646,272 gallons/day
	1.98 acre-feet/days
1 acre-foot =	43,560 cubic feet
	325,851 gallons

To ensure comparability of findings, these rates should be used.

Upon approval by the Planning Director and County Counsel, the rate of water use by the proposed development may be altered if the applicant demonstrates that water conservation practices or programs will reduce consumption (see Subsection 1006.03(F)(3)(c)). The reduction must be based upon the assumption that a "typical" residence uses 400 gallons per day for residential use and 2,000 gallons per day for irrigation from June through September, and that the conservation measures will reduce consumption from that level. *If water conservation practices or programs are used to reduce the rate of water use, they shall be clearly described in the Report and be recorded in the property's deed of record, including specific practices followed, who is implementing the practices or program and reasonable expectations for continuation of the practices or program. The peer reviewer shall document any such practices and programs in the peer-review report. Practices to be implemented on the subject property may be included as a condition of approval for subsequent land use applications.*

AQUIFER SUSTAINABILITY

A section addressing aquifer sustainability must be included in the Hydrogeologic Review Report. The report needs to include a discussion of evidence of aquifer stability, and a description of the wells in the study area. Efforts should be made to contact as many owners (or the drillers) of deepened and replacement wells as possible. Describe how many well logs were examined, well owners contacted and other research performed, and the results of that research.

If this research finds evidence of well deepenings, the report needs to include an evaluation of identified well deepenings and replacements within the study area with a discussion of the consultant's conclusions regarding likely reasons. The detail of the evaluation may depend on how many deepenings have occurred. The report should address the relationship between deepenings and: (1) long-term water-level (head) trends, (2) groundwater use, (3) source aquifer, and (4) climate. The number and relative percentage of deepenings should be compared to the number of well logs identified in the study area. A high number of deepenings and/or replacements within the study area, or within a portion or the study area, should be evaluated and discussed in the report. As an example, the designation of a "high number" of deepenings may be based upon well type (i.e. domestic well deepenings as opposed to irrigation well deepenings may provide an indicator of groundwater decline or overdraft).

SPECIAL CIRCUMSTANCES

The SGAs in Clackamas County coincide with administrative areas delineated by the Oregon Water Resources Department that have known or suspected groundwater supply problems in a specific aquifer or groups of aquifers. The Hydrogeologic Review Report needs to assess whether the proposed groundwater source produces from one of these specified aquifers.

1. **Waivers**
   In compliance with Subsection 1006.03(F)(5) the Planning Director may, at the Director's discretion, waive some or all of the requirements for a Hydrogeologic Review Report outside of the Sensitive Groundwater Areas where an applicant demonstrates through well logs or other evidence that the specified information is not necessary to determine compliance with ZDO 1006.05B.

2. **Water Conservation and/or Reuse Measures**

The Planning Director may, at the Director's discretion and upon approval by the County Counsel, allow modifications to the water use assumptions in the Hydrogeologic Review Report when the applicant has proposed enforceable water conservation and/or reuse measures as defined in Subsection 1005.03(F)(3)(c) of the Clackamas County ZDO. Such measures can include but are not limited to gray water use, water conserving appliance and fixtures, drought resistant landscaping and rainwater harvest and/or use of cisterns.

3. **Public Water Requirements**
   Pursuant to Subsection 1006.03(F)(8) any subdivisions of 11 lots or more shall be served by a single public or community water source. The development would be exempt from the requirements in ZDO Section 1006 if these community or public water systems require a well permit from the state.

CONCLUSIONS

The primary purpose of the Hydrogeologic Review Report is to adequately demonstrate whether the standards in 1006.03(F)(2) are met. In arriving at this conclusion, the assumptions, and analyses discussed above need to be incorporated. These include:

1. The geologic conditions that affect recharge and discharge in the study area;
2. Analysis of why wells in the study area have been deepened or replaced;
3. Long-term water level trends in the area, if available;
4. Predicted water use in the study area using development of all existing lots and future development of the proposed lots on the subject property (including the water budget);
5. Evaluation whether the proposed use will or will not cause an unreasonable adverse affect the long-term water supply of existing uses, potential new uses on existing vacant parcels in the study area, and/or existing water rights; and
6. Assessment whether the proposed use will or will not "deplete" the groundwater resource and/or impact nearby surface water features over the short or long term.
7. Evaluation regarding whether adequate information exist to make reasonable conclusions based on the above-mentioned factors.

SUMMARY

Section 1006 of the Clackamas County ZDO requires that an applicant demonstrate that the certain proposed developments located outside the PMUGB will not result in unsustainable use of groundwater or impact to nearby existing surface water rights. Specific requirements regarding submittal of data on groundwater supply result in additional study if initial investigations indicate long-term decline of the resource may occur as the result of existing or new development.

Reports prepared by professional geologists or engineering geologists must be reviewed by a peer representing the county. The design and performance of required studies should be coordinated with the peer-reviewer. Changes may be used for the water balance, figures, and/or conclusions if agreement of the changes is approved by the County's peer reviewer. Any changes that are made to the Hydrogeologic Review Report during the peer review should be reflected in the text of the report. Replacement pages or an errata sheet must be submitted to Clackamas County so that a final report that includes all revisions and corrections can be placed in Clackamas County files. The peer review will not be mailed to the applicant unless three copies of all replacement pages or errata sheets are submitted to Clackamas County.

Clackamas County will submit peer-reviewed reports to the Oregon State Board of Geologist Examiners (OSBGE) if it comes to the County's attention that information provided in a

hydrology review or study has, or may have been, willfully omitted or distorted to influence the peer-reviewer's decision.

ADDITIONAL INFORMATION SOURCES

Clackamas County does not necessarily endorse particular methods, resources, and/or references provided below. However, this information is intended to assist with Hydrogeology Review Report preparation as needed.

(1) OWRD website links:

(a) General website:

http://www.wrd.state.or.us/

(b) Well log query:

http://apps.wrd.state.or.us/apps/gw/well_log/Default.aspx

(c) Groundwater level data/hydrograph interactive maps:
http://maps.google.com/maps?f=q&source=s_q&hl=en&geocode=&q=http:%2F%2Fwww1.wrd.state.or.us%2Fkml%2FOWRD_Observation_Wells_CLAC.kml&ie=UTF8

(d) Water rights platcard report:

http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_platcard.aspx

(2) Woodward, D.G., M.W. Gannett, and J.J. Vaccaro, 1998, Hydrogeologic Framework of the Willamette Lowland Aquifer System, Oregon and Washington: U.S. Geological Survey Professional Paper 1424-B, 82 p.

(3) Gannett, M.W. and R.R. Caldwell, 1998, Geologic framework of the Willamette Lowland aquifer system, Oregon and Washington: U.S. Geological Survey Professional Paper 1424A, 32p.

(4) Leonard, A.R., and C.A. Collins, 1983, Ground Water in the Northern Part of Clackamas County Oregon, State of Oregon Water Resources Department, Ground Water Report No. 29, 85p.

(5) Oregon Water Resources Department and the Oregon Department of Land Conservation and Development, 2002, Ground Water Supplies in the Willamette Basin, September 2002.

TABLE 1 EXAMPLE TABULAR WELL DATA

wl_county_code	OWRD well no.	Map Well ID	Approximate well elevation (ft amsl)	well owner last name	well owner first name	name_company	depth_first_water (ft bgs)	completed_depth (ft bgs)	post_static_water_level (ft bgs)	complete_date	use_domestic	township	township_char	range	range_char	sctn	qtr160	qtr40	tax_lot	street_of_well	longitude	latitude	max_yield (gpm)	Primary aquifer
CLAC	4853	1	n/a	SKORO	SLAVO	n/a	295	363	283	7/3/1989	X	2	S	3	E	16	n/a	n/a	n/a	2155 SE CURTIS RD. - CLACKAMAS	n/a	n/a	16	CRBG
CLAC	4854	2	450	HILL	LESTER	n/a	301	435	330	4/29/1989	X	2	S	3	E	16	SW	SE	n/a	n/a	n/a	n/a	10	CRBG
CLAC	4855	3	400	PENNER	DR GREG L	n/a	175	250	130	2/23/1989	X	2	S	3	E	16	NW	SE	n/a	n/a	n/a	n/a	100	CRBG
CLAC	4856	4	n/a	BIERLEIN	LEN	n/a	357	360	300	4/9/1982	X	2	S	3	E	16	n/a	SE	n/a	n/a	n/a	n/a	15	CRBG
CLAC	4857	5	500	LAMB	GARY A	n/a	634	654	422	10/18/1979	X	2	S	3	E	16	NW	NW	n/a	n/a	n/a	n/a	50	CRBG
CLAC	4858	6	n/a	PHELPS	RICHARD W	PHELPS, SHARON M	85	356	164	12/16/1976	X	2	S	3	E	16	NE	n/a	n/a	n/a	n/a	n/a	7	Basin Fill
CLAC	4859	7	520	BROOKMAN	WESLEY	n/a	265	312	101	1/25/1974	X	2	S	3	E	16	SW	SE	n/a	n/a	n/a	n/a	25	CRBG
CLAC	4860	8	580	OLDFIELD	ERNEST	n/a	145	180	118	8/31/1973	X	2	S	3	E	16	NE	NE	n/a	n/a	n/a	n/a	8	CRBG
CLAC	4861	9	450	LAMB	GARY A	n/a	85	96	66	5/5/1978	X	2	S	3	E	16	NW	NW	n/a	n/a	n/a	n/a	30	Basin Fill
CLAC	16051	10	n/a	BACHMAN	JOE	n/a	700	745	405	11/21/1991	X	2	S	3	E	16	n/a	n/a	1701	20700 SE KURTIS, CLACKAMAS	n/a	n/a	37	CRBG
CLAC	54509	11	430	ENGELSON	CHERYL	n/a	15	38	9.5	4/7/1999	X	2	S	3	E	16	NE	SW	2000	21212 SE CURTIS RD	n/a	n/a	6	Basin Fill

Notes:

Information modified from Oregon Water Resources Department well log database

ft amsl- feet above mean sea level

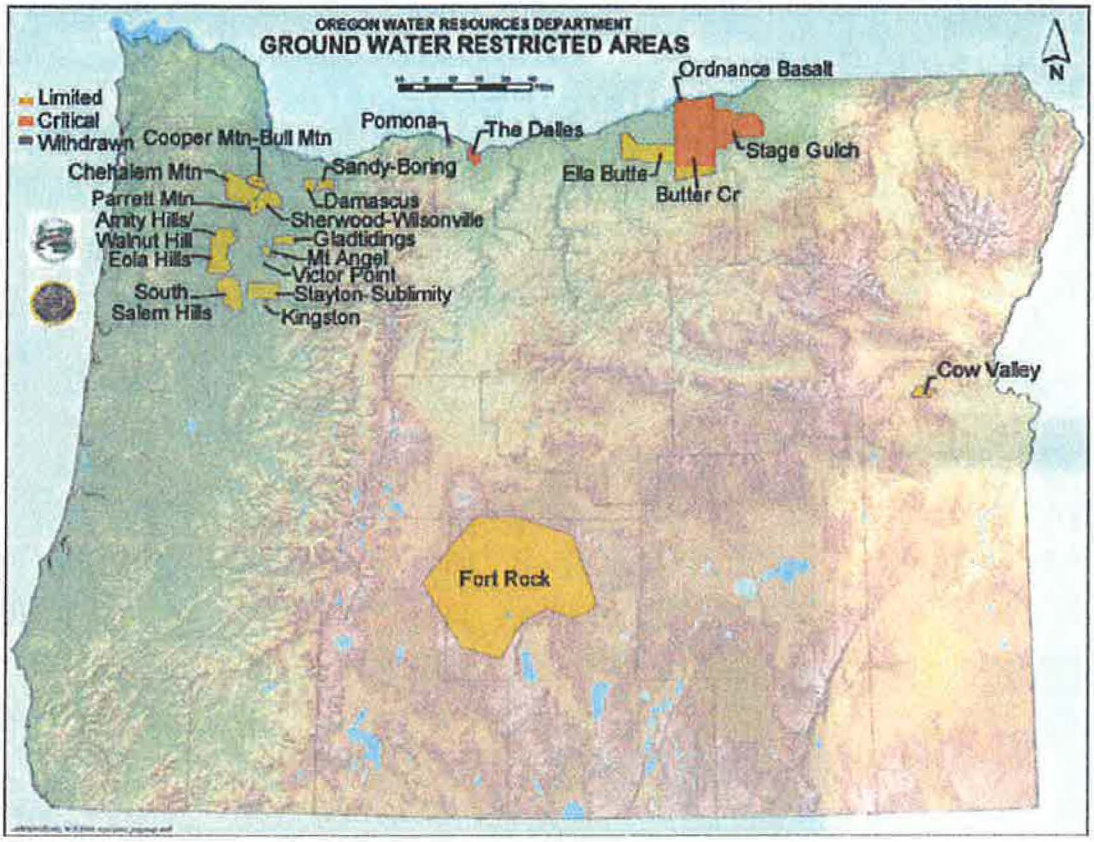
ft bgs- feet below ground surface

approximate well elevations determined from USGS 7.5 Minute Quadrangle

n/a- not available or not applicable

gpm- gallons per minute

CRBG- Columbia River Basalt Group

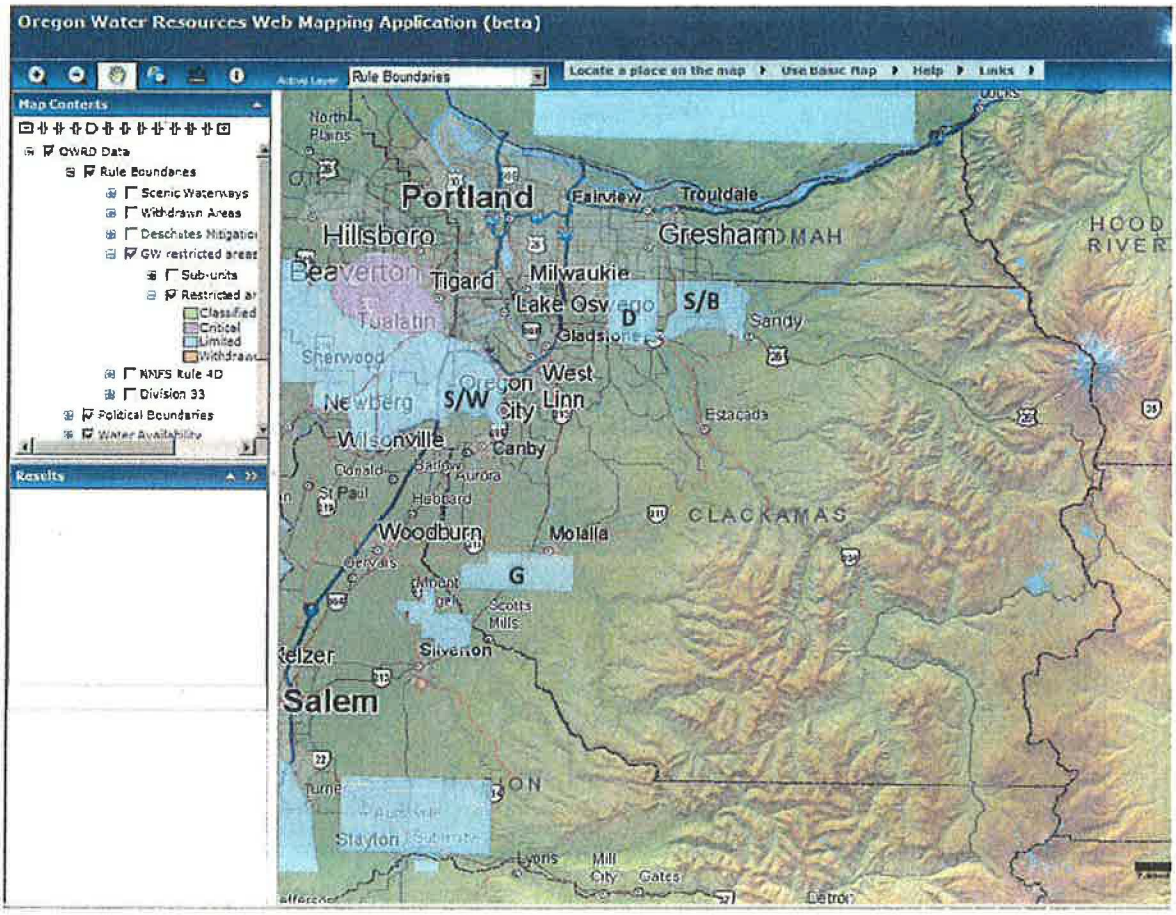


Source:
Oregon Water Resources Department, accessed January 2011.
website: http://www.oregon.gov/OWRD/GW/gw_critical_allocations.shtml

CLACKAMAS COUNTY

Figure 1

Map Showing Ground Water Restricted Areas in Oregon



Groundwater Limited Areas:

D = Damascus (CRB/BFS)

S/B= Sandy- Boring (BFS)

S/W= Sherwood-Wilsonville (CRB)

G= Gladtidings (CRB)

CRB= Columbia River Basalt

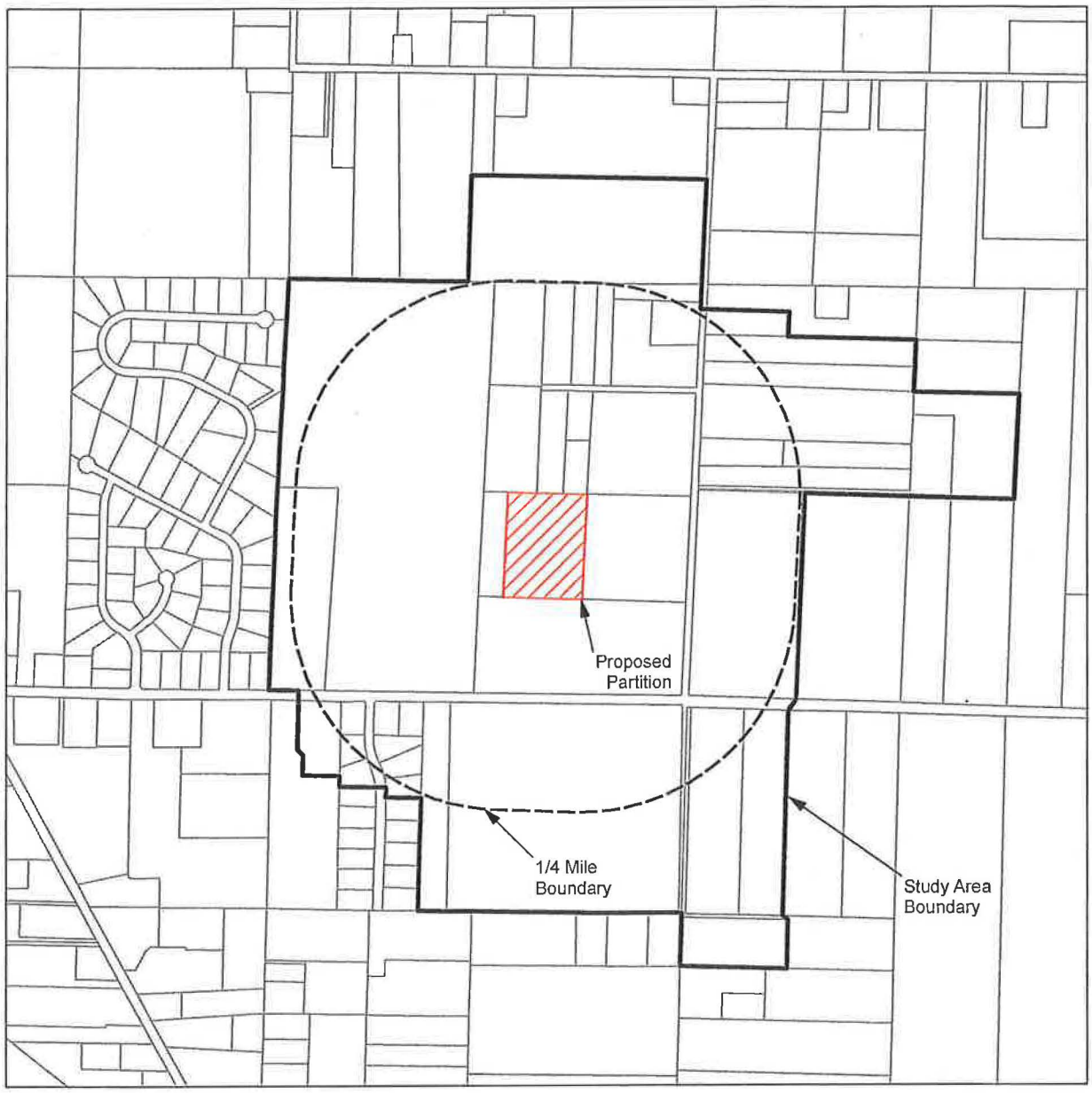
BFS= Basin Fill Sediment

CLACKAMAS COUNTY

Source:
Oregon Water Resources Department, accessed January 2011.
website: http://gis.wrd.state.or.us/apps/map/owrd_map/

Figure 2

Map Showing Groundwater Limited Areas
Within Clackamas County



LEGEND

- Study Area Boundary
- 1/4 Mile Boundary
- Proposed Partition
- Taxlots

CLACKAMAS COUNTY

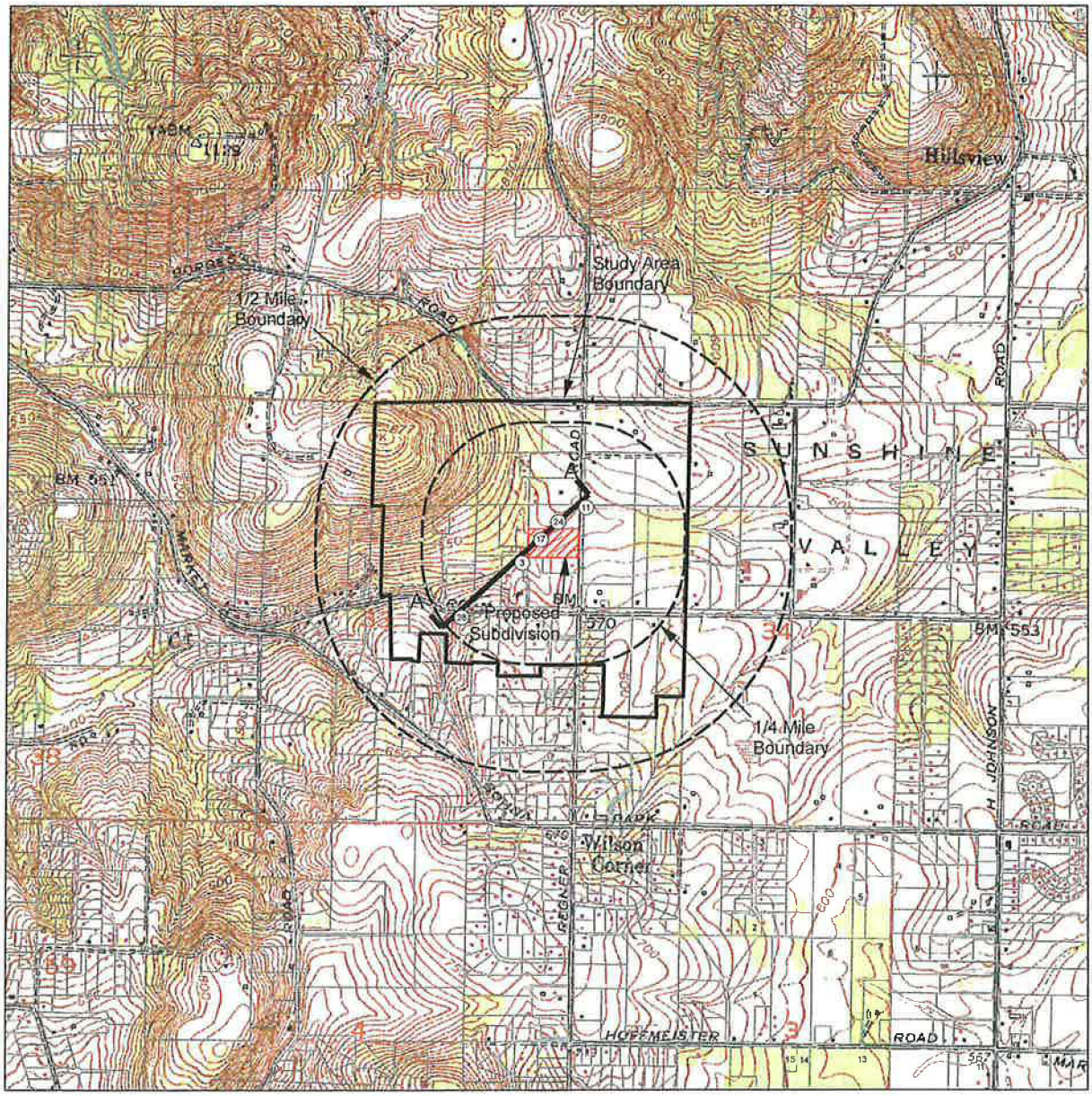
Source:
Taxlots - Metro Data Resource Center

0 500 1,000
Feet
Scale: 1 " = 1,000 '

N

Figure 3

Map Showing Entire Study Area
John Doe - T.2S. R.4E. Section 3DD 05200



LEGEND

- Proposed Subdivision
- Study Area Boundary
- Boundary (1/4 & 1/2 Mile Extents)
- A A' Cross Section Location
- (11) Well Location and ID No.
- Taxlots

CLACKAMAS COUNTY

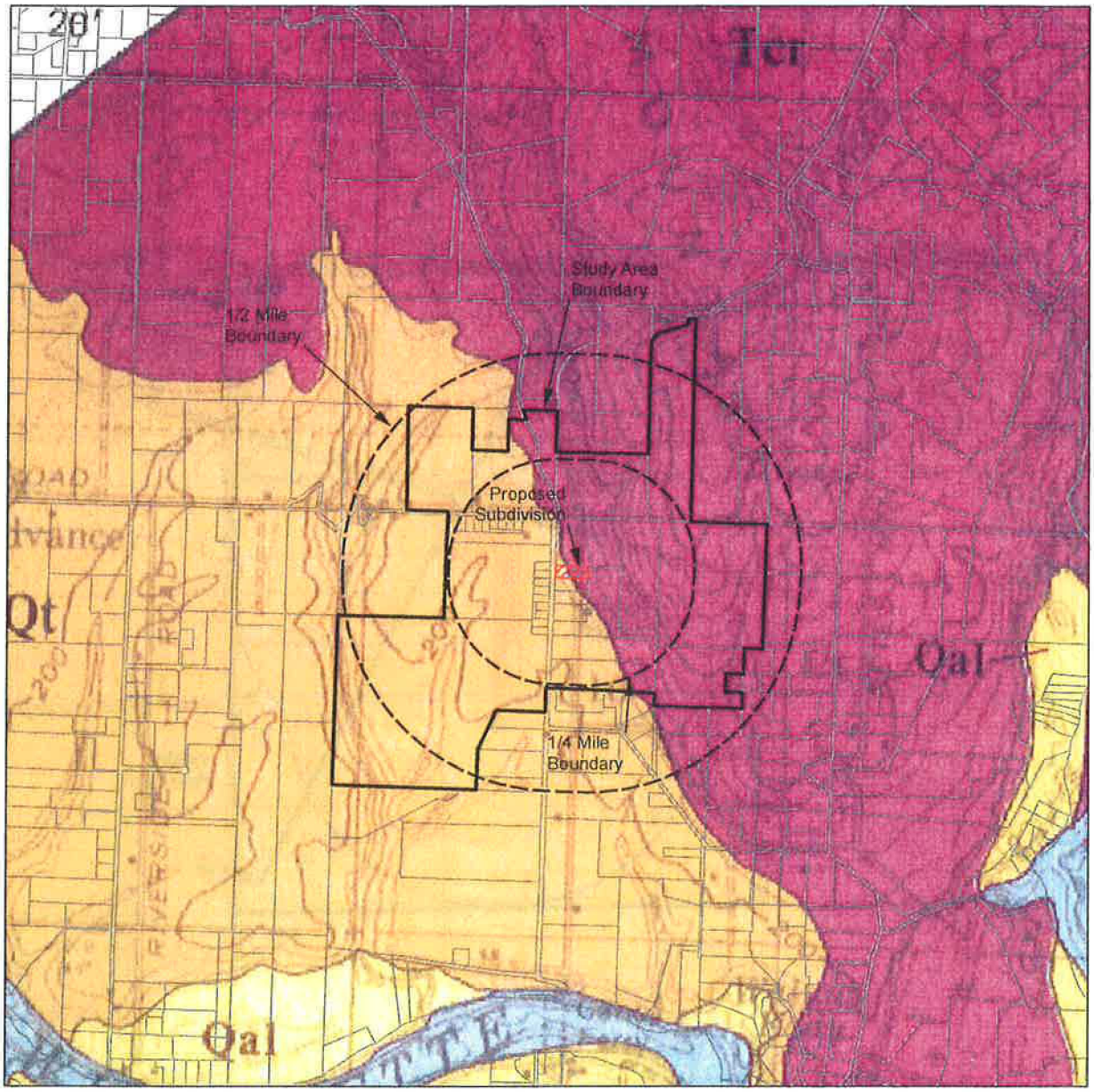
Source:
USGS 7.5 Minute Topographic Survey Map: Damascus, Oregon (45122D4)
Taxlots - Metro Data Resource Center

0 1,000 2,000 Feet

Scale: 1 " = 2,000 '

Figure 4

Site and Cross-Section Location Map
John Doe - T.1S. R.3E. Section 33A - Taxlot 900



LEGEND

Proposed Subdivision	Geologic Units
Study Area Boundary	Qal - Alluvium
Boundary (1/4 & 1/2 Mile Extents)	Qt - Terrace Deposits
Taxlots	Tcr - Columbia River Basalt Group

CLACKAMAS COUNTY

Source:
Geologic Map of the Northern Clackamas County Study Area, Oregon
Oregon Water Resources Department - Ground Water Report No. 29
Taxlots - Metro Data Resource Center

0 1,000 2,000
Feet
Scale: 1 " = 2,000 '

Figure 5

Regional Geology Map
John Doe - T.3S. R.1E. Section 16, Taxlot 204



LEGEND

- Proposed Partition
- Study Area Boundary
- Boundary (1/4 Mile Extent)
- A A' Cross Section Location
- ⑪ Well Location and ID No.
- Taxlots

CLACKAMAS COUNTY

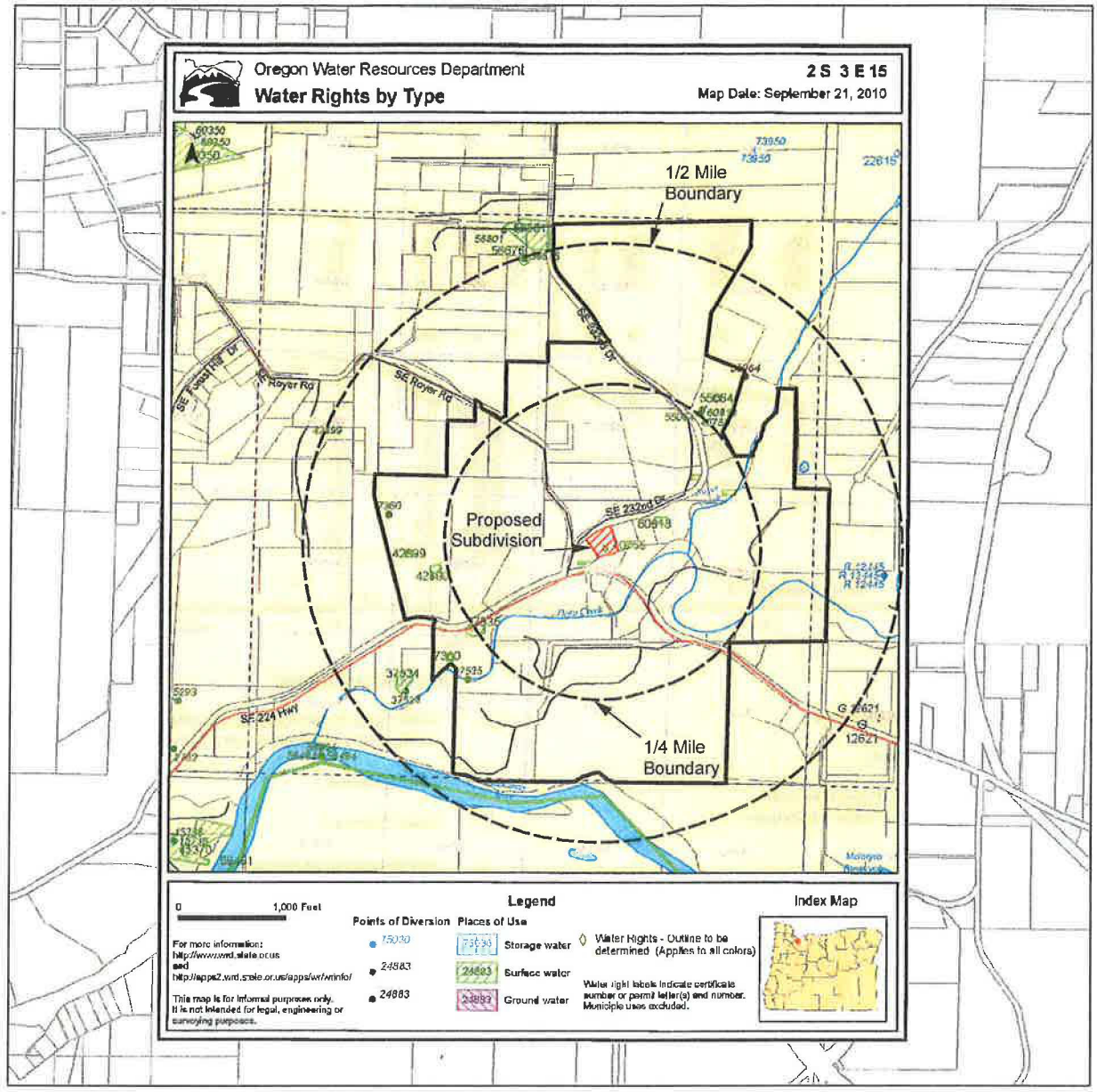
Source:
Taxlots - Metro Data Resource Center

0 500 1,000 Feet

Scale: 1 " = 1,000 '

Figure 6

Well and Cross Section Locations
John Doe - T.2S. R.3E. Section 3 - Taxlot 701



LEGEND

- Proposed Subdivision
- Study Area Boundary
- Boundary (1/4 & 1/2 Mile Extents)
- Taxlots

CLACKAMAS COUNTY

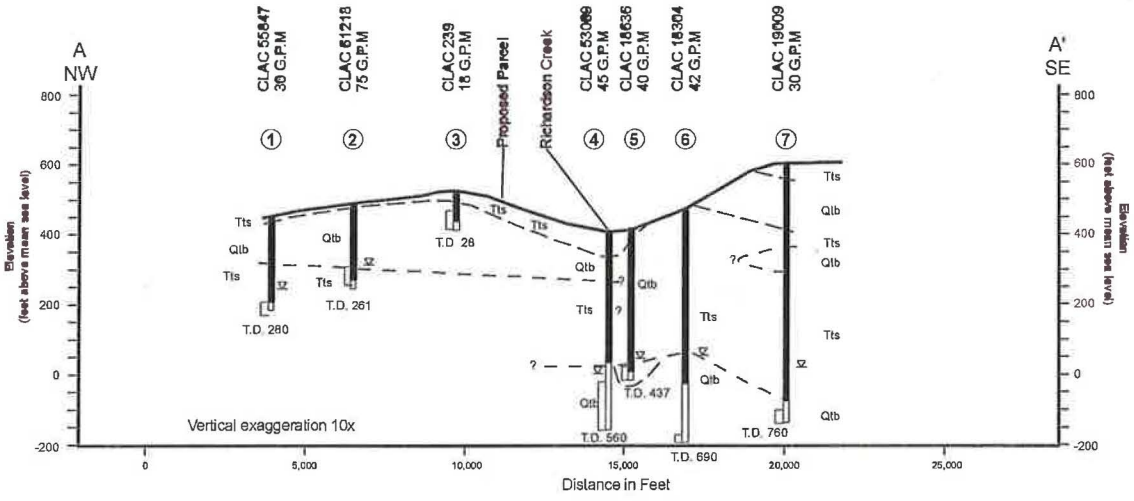
Source:
Taxlots - Metro Data Resource Center
Water Rights by Type - Oregon Water Resources Department

0 750 1,500 Feet

Scale: 1 " = 1,500 '

Figure 7

Water Rights
John Doe - T.2S. R.3E. Section 16 - Taxlot 00502



Geologic Formation Key

QTb - Boring Lava

Tts - Troutdale Formation and
Sandy River Mudstone

Dashed where inferred.
Locations are approximate.

Hydrogeologic Legend

▽	Static water level reported on driller's log 280 total completed depth below ground surface
▌	Cased interval
▯	Open interval
⊏	Water-bearing zone reported on log
①	Well ID used in report (unique ID)
CLAC 55847	OWRD Well ID (GRID)
G.P.M	Gallons per minute reported discharge
T.D	Total well depth

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Figure 8

Cross Section A-A'
John Doe - T.2S. R.3E. Section 8DB, Taxlot 200