Oregon
John A. Kitzhaber, MD, Governor

Water Resources Department
North Mall Office Building
725 Summer Street NE, Suite A
Salem, OR 97301-1271
503-986-0900
FAX 503-986-0904

MEMORANDUM

TO: Water Resources Commission

FROM: Phillip C. Ward, Director

SUBJECT: Agenda Item E-2, March 6, 2014

Deschutes Basin Ground Water Mitigation Program Five-Year Review

I. Issue Statement

This report provides the second five-year evaluation of the Deschutes Ground Water Mitigation Program required under OAR Chapter 690, Division 505. The Commission set up the five-year review as part of its adaptive management approach for the mitigation program. The Commission may direct the Department to initiate rulemaking or take other action.

II. Background

On September 13, 2002, the Commission adopted the Deschutes Ground Water Mitigation Rules and the Deschutes Basin Mitigation Bank and Mitigation Credit Rules. These rules implement Senate Bill 1033 (1995), HB 2184 (2001) and HB 3494 (2005). The rules provide for mitigation of impacts to scenic waterway flows and senior water rights, while allowing additional appropriations of ground water in the Deschutes Ground Water Study Area. By rule, the mitigation program allows only an additional 200 cubic feet per second (cfs) of new ground water use, referred to as the allocation cap.

The Commission is required to evaluate the mitigation program every five years consistent with OAR Chapter 690, Division 505-0500 (2). The Department completed its first five year evaluation of the Mitigation Program in February 2008, which addressed the years 2003 through 2007. This second, five-year evaluation of the program evaluates the Mitigation Program from 2008 through 2012.

Depending upon the outcome of this evaluation, the Commission may determine whether the 200 cfs cap on new ground water allocations may be lifted or otherwise modified. In addition, if scenic waterway flows are met less frequently as compared to the long-term, representative base period flows, the Commission must initiate proceedings to declare all or part of the basin a critical groundwater area, close all or part of the basin to additional groundwater use, or take other administrative action.

III. Discussion

This report provides a summary of the results of the second five-year evaluation. The full report is provided as Attachment 1. The first five-year evaluation of the program is provided in Attachment 2.

A. Evaluation Criteria

The primary metric for evaluation of the Deschutes Mitigation Program is whether scenic waterway and instream water right flows continue to be met on at least an equivalent or more frequent basis as compared to long-term, representative base-period flows established by the Department. The rules also require an evaluation of the program itself including: associated mitigation; the zones of impact; and the effectiveness of mitigation projects and mitigation credits that involve time-limited instream transfers, instream leases, and allocations of conserved water from canal lining and piping projects.

To evaluate the mitigation program, the Department relied upon two basic tools: 1) tracking of data associated with new ground water permits, pending ground water permit applications, mitigation projects, and mitigation credit transactions, and 2) an instream flow model. The instream flow model is described in Attachment 3 (Appendix A).

B. Summary of Evaluation Results

- 95 ground water permits have been issued since the mitigation program was adopted.
- 71% of the 200 cfs cap has been allocated under final orders and new ground water permits.
- Pending applications do not exceed the remaining balance of the 200 cfs cap.
- Mitigation established over the last five years of the Mitigation Program continued to exceed the amount needed (including for reserves) on average by 46%.
- The majority of ground water mitigation has been provided in the general zone of impact.
- In the 10 year history of the Mitigation Program, mitigation has been provided solely by instream leases and instream transfers.
- Temporary mitigation credits established from instream leases have consistently provided sufficient mitigation to meet ground water permit needs and reserves.
- Each year, the cumulative amount of permanent mitigation provided by instream transfers has increased.
- Mitigation provided in each zone of impact met requirements for new ground water uses for each zone.
- More than 51 cfs of instream flow has resulted from permanent and temporary mitigation.
- Improvements in summer streamflow continue to occur in critically low flow reaches due to the mitigation program.
- Small declines in winter streamflow occurs in some reaches, which is an expected result of the mitigation program.
- Scenic waterway and instream water right flows continue to be met at nearly identical levels annually when compared to the base-period flows.
- Streamflows have improved by as much as 11 CFS annually in some areas due to mitigation.

C. Next Steps

It has been ten years since the Department's administrative rules for the Deschutes Mitigation Program were adopted by the Commission. The evaluation provided in Attachment 1 demonstrates that the program is working and that instream requirements are being met more frequently as compared to representative based-period flows.

Based on this evaluation, the Commission may determine whether the 200 cfs cap on new ground water allocations may be lifted or otherwise modified. The Department does not believe that lifting or modifying the cap is necessary at this time. There is still water available under the cap, and as outlined below, the amount available under the cap could be increased by allowing the Department to reallocate water previously allocated to a now cancelled permit, regardless of how the permit was cancelled.

As identified in the five-year evaluation for 2008 through 2012, the Division 522 administrative rules limit how the Department can add water back to the amount available under the allocation cap and reestablish mitigation credits when a permit is cancelled. Division 522 limits the reestablishment of mitigation credits to instances when the permit is cancelled under ORS 537.410, which is an infrequently used cancellation process. The rules do not include other cancellation processes, including voluntary cancellation. Once a permit is cancelled, water is no longer pumped from the well and mitigation is no longer needed. It seems reasonable that the Department should be able to add water back to the amount available under the allocation cap and allow the reassignment of mitigation credits regardless of how a permit may have been cancelled.

IV. Alternatives

The Commission may consider the following options consistent with the Division 505 rules:

1. Accept report and direct staff to initiate rulemaking to modify Division 522 to clarify how the Department adds water back to the amount available under the allocation cap and reestablishes mitigation credits upon cancellation of a permit.
2. Direct staff to report back after further review of the program.
3. Accept report.

V. Staff Recommendations

The Department recommends Alternative 1, to accept report and direct staff to initiate rulemaking to modify Division 522 to clarify how the Department adds water back to the amount available under the allocation cap and reestablishes mitigation credits upon cancellation of a permit.

Attachments:

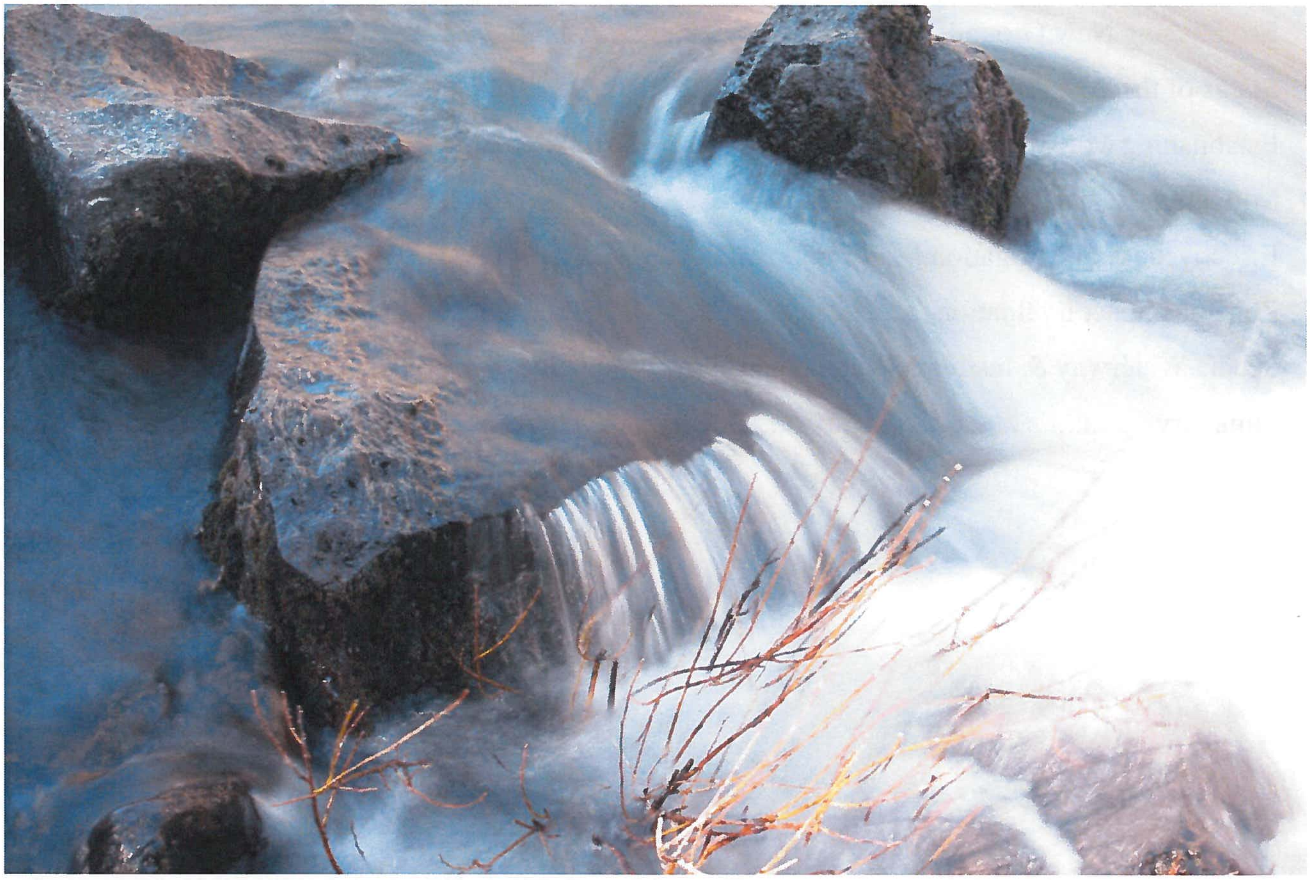
1. Deschutes Ground Water Mitigation - Five-Year Program Evaluation Report (2008 – 2012)
2. Deschutes Ground Water Mitigation - Five-Year Program Evaluation Report (2003 – 2007)
3. Assessing the Impact of Mitigation on Stream Flow in the Deschutes Basin – Appendix A

Dwight French
(503) 986-0819

Attachment 1

Deschutes Groundwater Mitigation Program

Five-Year Program Evaluation Report



March 6, 2014

State of Oregon
Water Resources Department

5-Year Evaluation of the Deschutes Groundwater Mitigation Program

Table of Contents

Introduction..1
Mitigation Program Development 3
Establishing New Groundwater Uses 6
Status of the 200 Allocation Cap 6
Establishing Mitigation Water and Credits...9
Mitigation Banks 10
Effectiveness of Mitigation Projects...12
Zone of Impact Evaluation 20
Scenic Waterway & Instream Water Right Flow Evaluation..37
Summary...41

Special thanks to Kyle Gorman, WRD,
for the cover photograph used in this report

Introduction

The Deschutes Groundwater Mitigation Program was developed to provide for new groundwater uses while maintaining scenic waterway and instream water right flows in the Deschutes Basin. The program is authorized under ORS 537.746, House Bill 3494 (2005 Oregon Laws), and most recently HB 3623 (2011 Oregon Laws) and implemented in Oregon Administrative Rules (OAR) Chapter 690, Divisions 505, 521, and 522.

Every five years the Water Resources Commission (WRC) is required to evaluate the effectiveness of the mitigation program under OAR 690-505-0500(2). The Oregon Water Resources Department (OWRD) completed its first five-year evaluation of the mitigation program in 2008 covering 2003 through 2007 (Attachment 2). This is the second five-year evaluation of the mitigation program and covers 2008 through 2012. The purpose of this evaluation is to ensure that scenic waterway and instream water right flows continue to be met on at least an equivalent or more frequent basis compared to flows within a representative base period. Depending upon the outcome of this evaluation, the WRC may modify the program accordingly (OAR 690-505-0500(5)). This may include adjusting the allocation cap on new groundwater uses that was established under the program. The WRC may also initiate proceedings to declare all or part of the basin a critical groundwater area, close all or part of the basin to additional groundwater use, or take other administrative action. This report provides the background and evaluation material to help inform the WRC as it reviews the program.

Mitigation Review Criteria

- *Whether scenic waterway and instream water right flows continue to be met on at least an equivalent or more frequent basis as compared to long-term, representative base period flows established by the Department;*
- *Evaluation of the mitigation program, associated mitigation, the zones of impact; and*
- *Evaluation of the effectiveness of mitigation projects and mitigation credits that involve time-limited instream transfers, instream leases and allocations of conserved water from canal lining and piping projects.*

Evaluation Summary

- *95 new ground water permits have been issued since the Mitigation Program was adopted by the Commission.*
- *71% of the 200 cfs cap has been allocated under final orders and new ground water permits.*
- *Pending applications do not exceed the remaining balance of the 200 cfs cap.*
- *Mitigation established over the last five years of the Mitigation Program continued to consistently exceed the amount needed (including for reserves).*
- *In the 10 years of the Mitigation Program, mitigation has been provided solely by instream leases and instream transfers.*
- *Temporary mitigation credits established from instream leases has consistently provided sufficient mitigation to meet ground water permit needs and reserves.*
- *Each year, the cumulative amount of permanent mitigation provided by instream transfers has increased.*
- *The majority of ground water mitigation has been provided in the general zone of impact.*
- *Mitigation provided in each zone met requirements for new ground water uses for each zone.*
- *More than 51 cfs of instream flow as a result of permanent and temporary mitigation.*
- *Improvements in summer streamflow continue to occur in critically low flow reaches due to the mitigation program.*
- *Small declines in winter streamflow also occur in some reaches, which is an expected result of the mitigation program.*
- *Scenic waterway and instream water right flows continue to be met at nearly identical levels annually compared to the base-period flows.*
- *Overall, streamflows have been improved by as much as 11 cfs annually in some areas due to mitigation.*

Mitigation Program Development

Much of the mainstem Deschutes River and its tributaries are protected by scenic waterway designations and instream water rights. There are also existing surface water rights on the Deschutes River and its tributaries for out-of-stream uses, such as irrigation and municipal.

In the Deschutes Basin above Lake Billy Chinook, as demonstrated by a groundwater study completed by the U.S. Geological Survey in cooperation with the Oregon Water Resources Department and various other partners, there is a hydraulic connection between groundwater and surface water flows within the Deschutes Groundwater Study Area (DGWSA) (Figure 1). Because of this connection, groundwater withdrawals affect surface water flows.

The 1995 amendments to the Scenic Waterway Act require the examination of each groundwater right to determine whether the groundwater use will "measurably reduce" surface flows necessary to maintain the free flowing character of the scenic waterway. The statute also requires mitigation by new groundwater applicants once the measurably reduced standard is triggered. In 1998, OWRD determined, based on the Deschutes Groundwater Study, that the measurable reduction standard had been triggered.

Since no further reductions in scenic waterway flows could be allowed and scenic waterway flows and instream water rights were not always satisfied, the Department could not approve new groundwater permits within the DGWSA unless the impacts were mitigated.

In June 2001, House Bill 2184 was enacted into law, authorizing a system of mitigation credits and banking arrangements. On September 13, 2002, the WRC adopted the Deschutes Groundwater Mitigation Rules (Division 505) and the Deschutes Basin Mitigation Bank and Mitigation Credit Rules (Division 521). The rules adopted by the WRC provide for a set of tools that groundwater permit applicants can use to establish mitigation for impacts to scenic waterway flows and senior water rights, and, thereby, obtain new permits from OWRD in the Deschutes Groundwater Study Area (DGWSA) (Figure 1).

The rules also set an allocation cap limit of 200 on the amount of new groundwater use that can be approved under the Mitigation Program and required OWRD to evaluate and report on the mitigation program both annually and every five years (OAR 690-505-0500).

In 2005, the Legislature also passed HB 3494 to affirm the Deschutes Mitigation Program. HB 3494 (2005 Oregon Laws) directed OWRD to report to the 75th Legislative Assembly, no later than January 31, 2009, on the implementation and operation of the Deschutes River Basin Groundwater Mitigation and Mitigation Bank Programs. HB 3494 also provided for a January 2, 2014 sunset of the Mitigation Program.

The HB 3494 report was presented to the Legislature in January 2009, identifying a number of recommendations that led to additional rulemaking. On June 4, 2010, the WRC adopted the Deschutes Basin Water Management Rules (Division 522), which operate in conjunction with the Deschutes Groundwater Mitigation Rules (Division 505) and the Deschutes Basin Mitigation Bank and Mitigation Credit Rules (Division 521). The Deschutes Basin Water Management

Rules built upon the recommendations from the HB 3494 report. The rules changed how OWRD counts new groundwater permit applications under the allocation cap and allows some unused mitigation credits to be reassigned. The new rules also clarified how municipal and quasi-municipal permit holders provide mitigation under the incremental development plans and allow the additional flexibility to use "offsets" and to move mitigation credits between permits.

In 2011, the Legislature passed HB 3623, which modified the sunset date on the Mitigation Program to January 2, 2029. HB 3623 also requires the Department to periodically review the Mitigation Program for potential regulatory and statutory changes. In addition, OWRD is required to report to the Legislative Assembly every five years. The first of these reports will be due in 2016.

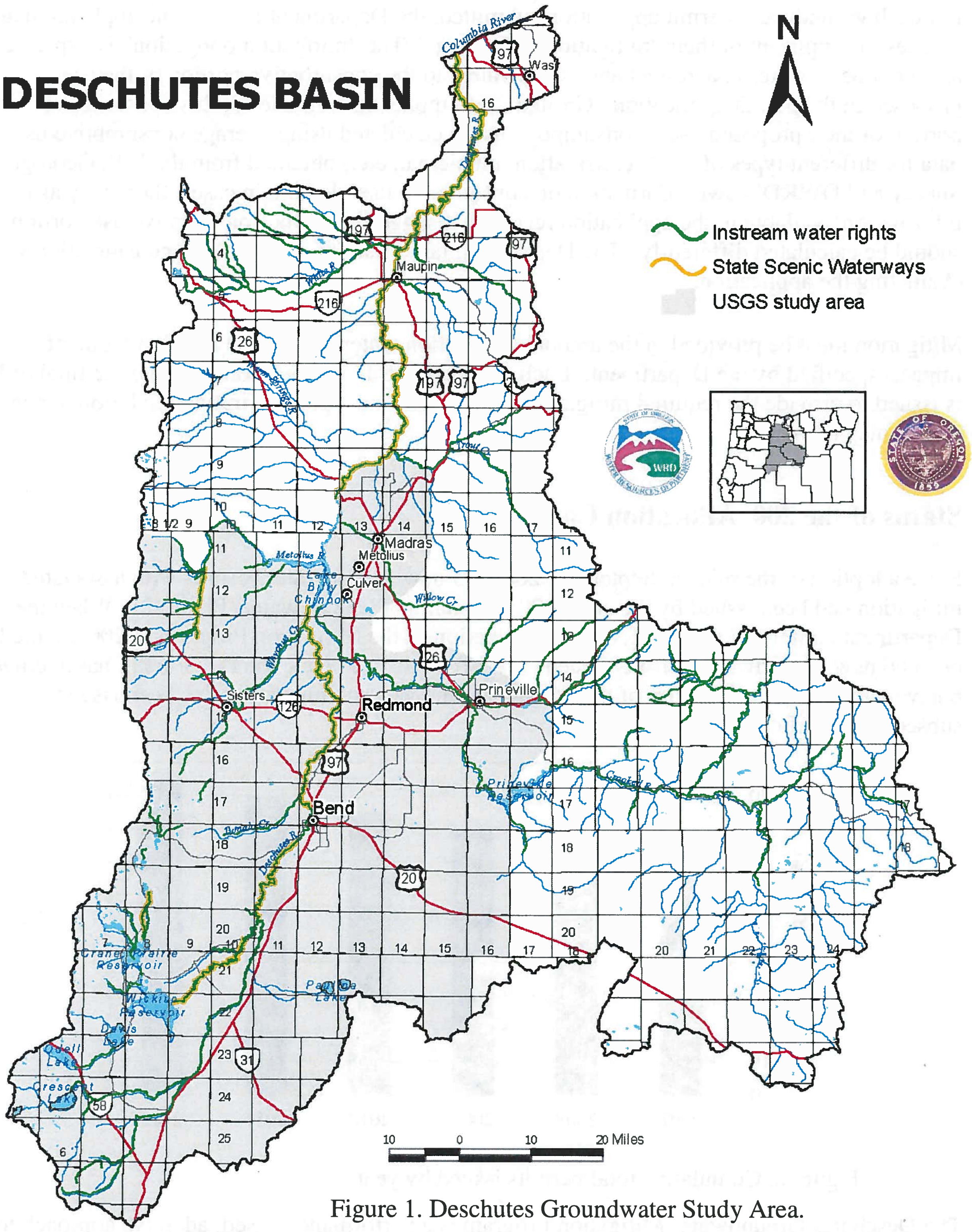


Figure 1. Deschutes Groundwater Study Area.

OWRD GIS (rh), 1/3/2008, des/desfig_USGS_ISWR_SSW.mxd

Establishing New Groundwater Uses

For each groundwater permit application submitted, the Department reviews the application and notifies the applicant of their "mitigation obligation." The "mitigation obligation" is expressed as a volume of water in acre-feet and is equivalent to the consumptive portion of the use proposed in the permit application. Groundwater applicants mitigate for this consumptive portion of their proposed use. Consumptive use is calculated using average consumptive use data for different types of use (i.e. irrigation, municipal, etc.) obtained from the U.S. Geological Survey and OWRD's own information on consumptive use. In certain cases, there may also be information available in the application record that suggests that the consumptive use portion should be calculated differently. The Department takes that information into consideration when evaluating the application.

Mitigation must be provided in the amount (mitigation water) and in the location (zone of impact) specified by the Department. Each applicant has five years from the date the final order is issued to provide the required mitigation. Applicants must provide mitigation before a new permit may be issued.

Status of the 200 Allocation Cap

Since adoption of the rules in September 2002, 95 new groundwater permits with associated mitigation had been issued by the end of 2012, totaling 88 cfs of water (Figure 2). When the Department completed the first five-year evaluation of the Mitigation Program in 2007, there had been 66 new groundwater permits issued. Over the last five years, the Department has averaged 6 new permits each year. Four of the 95 new groundwater permits have also been issued subsequent certificates.

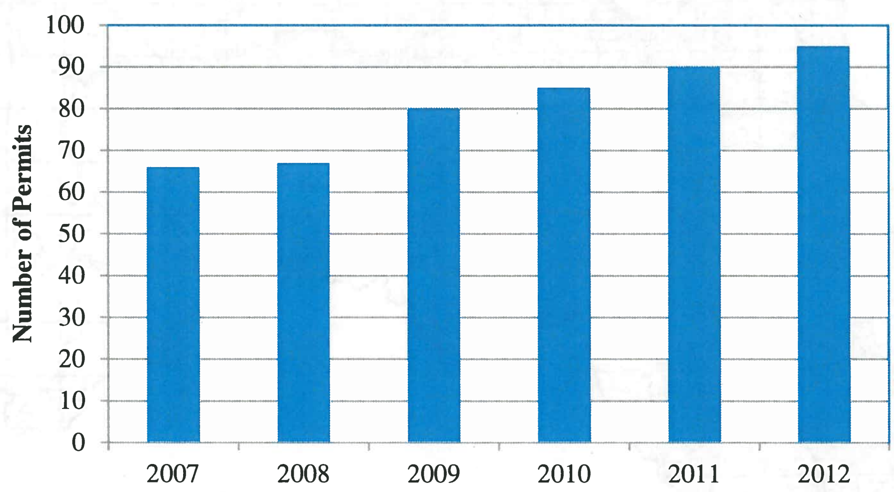


Figure 2. Cumulative total permits issued by year.

The Deschutes Groundwater Mitigation Program is a performance based, adaptive approach to managing new groundwater permits in the Deschutes Groundwater Study Area. As part of this adaptive approach, the program included a cap on how much new groundwater use could be approved. The Department may issue final orders approving groundwater permit applications for a cumulative total of up to 200 cfs. This limitation is one of the elements of the program that is to be reviewed as part of the program evaluation. The 200 cfs cap represents the rate up to which water may be withdrawn from the groundwater resource. It is important to note that this rate-based limitation is different from the consumptive use portion (in acre-feet) for which groundwater permit applicants must provide mitigation.

The rate proposed for a new groundwater use is deducted from the 200 cfs cap upon issuance of a Final Order approving the new application. As shown in Figure 3, the cumulative amount of water as of the end of 2012 approved in new permits and in permit applications with final orders was 141 cfs. This is roughly 71% of the total amount allowed under the allocation cap and leaves a remaining balance of 59 cfs available for new appropriations not yet debited from the application cap. A summary of water debited from the cap by type of use is provided in Figure 4.

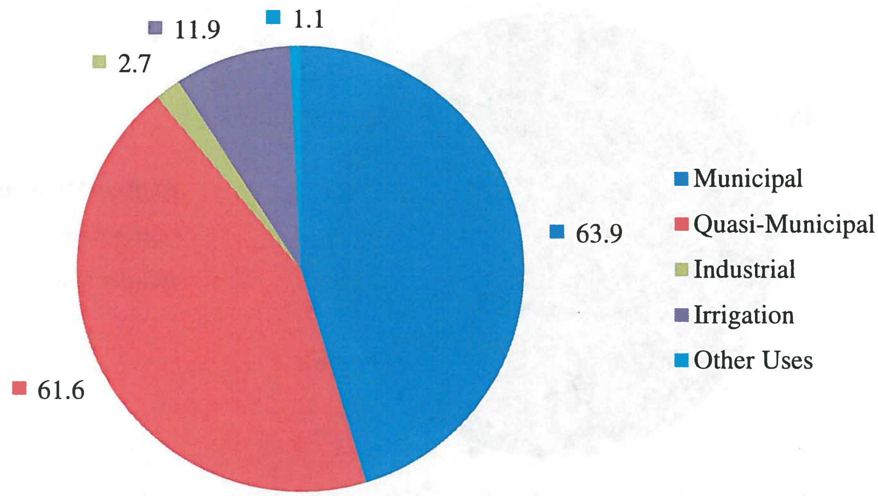


Figure 3. Amount of water in cfs of the 200 cfs allocation cap that has been allocated under new permits and final orders.

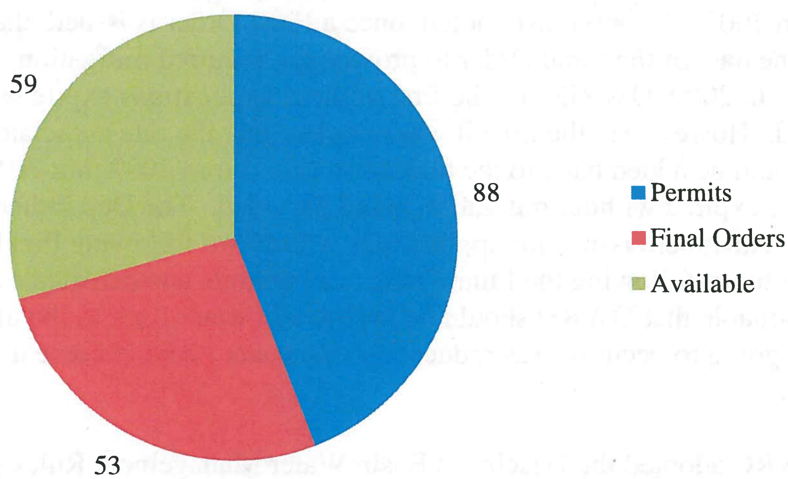


Figure 4. Amount of water in cfs of the 200 cfs allocation cap that has been allocated under new permits and final orders by type of use.

When OWRD completed the first five-year evaluation of the mitigation program, approximately 85 cfs had been debited from the allocation cap. There were also another 40 applications pending. In sum, a total of 144 cfs had not yet been debited from the allocation cap. This exceeded the amount of water available under the cap at that time by 29 cfs. However, as applications move up the application "queue", the amount of water requested is sometimes modified reducing the requested rate. Other times, applications are withdrawn or denied. If these actions occur prior to the use being debited from the allocation cap, the cap is debited appropriately based on the application status at the time of the Final Order.

As of year-end 2012, there were 18 applications pending without a Final Order totalling 58 cfs. As of the end of 2012, there was also 59 cfs available under the allocation cap.

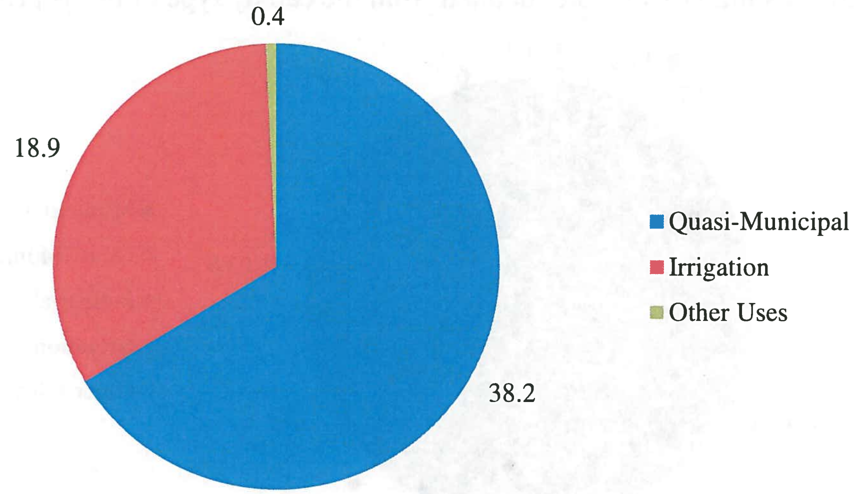


Figure 5. Amount of water in cfs of pending groundwater applications without final orders by type of use.

In its previous five-year evaluation, OWRD identified 10 applications with Final Orders that could expire in 2009. As previously noted, once a Final Order is issued, the permit applicant has 5 years from the date of the Final Order to provide the required mitigation, otherwise the Final Order expires. In 2009, OWRD saw the first of these applications expire without mitigation being provided. However, at the time it was not clear that the rate associated with these applications could be added back to the allocation cap. From 2009 thru 2012, 14 Final Orders, totaling 4.6 cfs, expired without mitigation being provided. The Department also identified allocation cap adjustment issues for applications withdrawn following Final Order issuance, applications reduced following the Final Order, and permits and certificates that were cancelled. It seemed reasonable that OWRD should be able to add water back to the allocation cap if a use was no longer going to occur or was reduced, so the water could become available for other proposed uses.

In 2010, the WRC adopted the Deschutes Basin Water Management Rules (Division 522), which identified changes to how new groundwater uses are debited from the allocation cap. Between the adoption of the Division 522 rules in 2010 and the end of 2012, the Department added back approximately 7 cfs to the water available under the allocation cap (Figure 6).

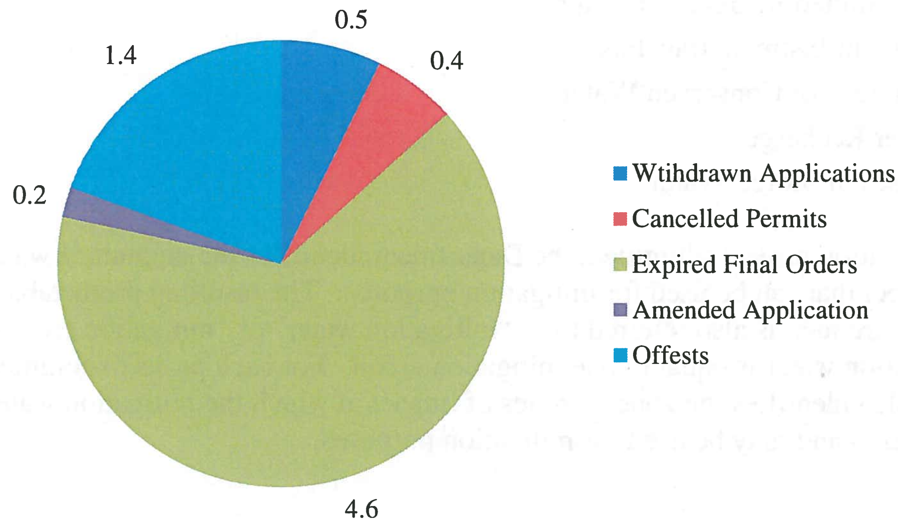


Figure 6. Amount of water in cfs added back to the 200 cfs allocation cap by category.

Water may also be added back to the allocation cap if a certificate is cancelled or if the certificate is issued for less than what was authorized by the permit. However, with cancellation, the Division 522 rules limit the type of cancelled permits and certificates to those cancelled under specific statutes. For example, permit cancellation is limited to ORS 537.410, a little used cancellation process. The rules do not include other statutes under which a permit may be cancelled, including voluntary cancellation. Through 2012, four permits have been cancelled (0.42 cfs). However, none of these were cancelled under ORS 537.410. Because of the way the rules were written, none of this water was added back to the allocation cap. Staff will be recommneding that the rules be modfied so that all types of permit cancellation result in water being added back to the cap.

As of October 31, 2013, there was 136 cfs debited from the allocation cap, leaving 64 cfs remaining. Applications pending without a final order total 37cfs , which is under the remaining available cap by 27 cfs.

Establishing Mitigation Water and Credits

The Deschutes Basin Groundwater Mitigation Rules provide groundwater permit applicants two options to satisfy the requirement to mitigate: 1) completion of their own mitigation project or 2) acquisition of mitigation credits.

The rules identify several types of projects that can be used to establish mitigation water:

- Instream Leases[1]

[1] Instream leases and time-limited instream transfers are temporary in nature and may only be used by mitigation banks to establish mitigation credits.

- Time-Limited Instream Transfers
- Permanent Instream transfers
- Allocations of Conserved Water
- Aquifer Recharge
- Releases of Stored Water

For each mitigation project submitted, the Department identifies the amount of water resulting from the project that can be used for mitigation purposes. The resulting protectable water, expressed in acre feet, is also referred to as "mitigation water" or "mitigation credits." One acre-foot of mitigation water is equal to one mitigation credit. For each project submitted, the Department also identifies the zone or zones of impact in which the mitigation water provides instream benefits and may be used for mitigation purposes.

Mitigation Banks

The Deschutes Basin Mitigation Bank and Mitigation Credit Rules (Division 521) provide for the formation of mitigation banks for the Deschutes Basin. Anyone may apply to become a mitigation bank. Successful applicants must enter into an agreement, called a mitigation bank charter, with the Department. Each charter must be approved by the WRC. Only two mitigation banks have been chartered by the WRC, the DRC Mitigation Bank and the Deschutes Irrigation Mitigation Bank. The Deschutes Irrigation Mitigation Bank has not completed any transactions through the mitigation bank.

Deschutes River Conservancy Mitigation Bank

The first mitigation bank to be established was the Deschutes Water Exchange (DWE) (affiliated with the Deschutes River Conservancy). The DWE Mitigation Bank was authorized under a charter agreement approved by the WRC in February 2003. In 2008, with WRC approval, the DWE Mitigation Bank changed their name to the Deschutes River Conservancy (DRC) Mitigation Bank.

In the first five years of the mitigation program (2003 through 2007), the primary source of mitigation in the DGWSA had been mitigation credits held by the DRC Mitigation Bank. The DRC Mitigation Bank has been the sole source of temporary mitigation credits generated by instream leases. In the last five years, the primary source of mitigation credits has shifted away from temporary mitigation credits held by the DRC Mitigation Bank to other permanent sources of mitigation.

However, demand and supply of mitigation credits from the DRC Mitigation Bank has remained fairly steady over the last five years in both quantity of mitigation credits and in the number of mitigation clients contracting with the bank to obtain mitigation credits. The mitigation bank has an average of 30 clients each year. Figures 7 and 8 shows the number of annual clients with existing permits and the total volume of mitigation credits allocated to those clients.

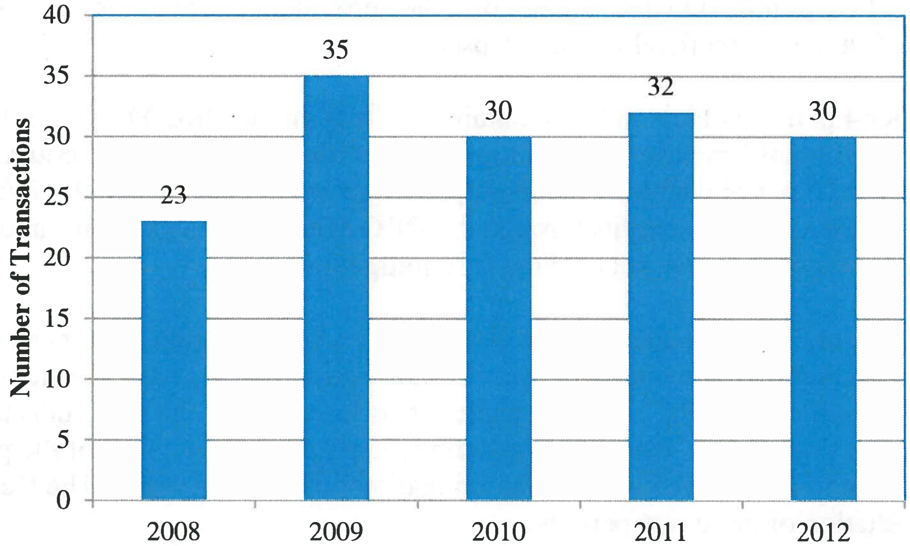


Figure 7. Number of Mitigation Bank Transactions by Year.

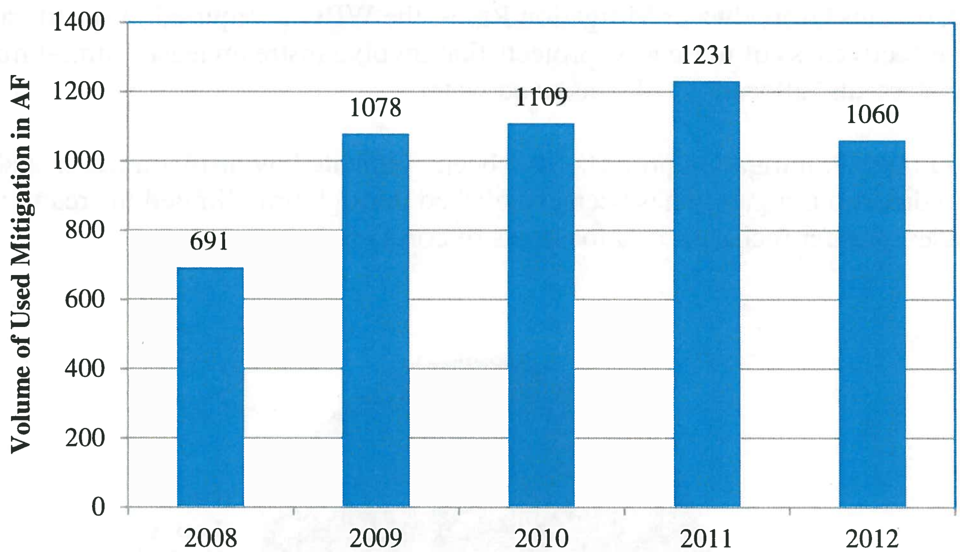


Figure 8. Annual Mitigation Bank Demand (including reserves).

Temporary mitigation credits (instream leases) from the DRC Mitigation Bank must be obtained by Bank clients on an annual basis. In the last five years, the DRC Mitigation Bank has identified a number of Mitigation Bank clients (permit holders) that have failed to obtain temporary mitigation credits and have not replaced that mitigation with another source, such as permanent mitigation credits. In 2008, 3 permit holders did not obtain mitigation through the DRC Mitigation Bank and did not replace the mitigation with an alternate source. One of these permits was voluntarily cancelled in 2008 and another in 2009. The third of these permits, which had not provided mitigation since 2006, was cancelled directly by the Department in 2012. The water use under this third permit had not been developed and the permit was cancelled following the expiration of the completion date specified in the permit and after the time period for submitting the Claim of Beneficial Use had lapsed.

In 2010, another 4 permit holders failed to obtain credits from the DRC Mitigation Bank. Several of the permit holders have gone multiple years without obtaining the required mitigation. In 2012, there were 5 permits without the required mitigation in place where the source of mitigation had been temporary credits through the DRC Mitigation Bank. This amounts to 50.1 AF of potential consumptive use not covered by a mitigation source.

The DRC Mitigation Bank has attempted to contact each of these permit holders and remind them of the mitigation requirement each year. Certain permit holders have re-established mitigation as a result of the DRC's efforts, while others have not. If the DRC fails to receive a response after a period of time, they stop contacting the permit holder. Two of the permits without mitigation in 2012 have not provided mitigation for multiple years. The Department is pursuing cancellation of these two permits.

Effectiveness of Mitigation Projects

Under the Deschutes Groundwater Mitigation Rules, the WRC is required to specifically evaluate the effectiveness of mitigation projects that involve instream leases, time-limited instream transfers, and allocations of conserved water.

As shown in Figure 9, mitigation projects have been dominated by instream leases and instream transfers. To date, no mitigation has been established through time-limited instream transfers, storage releases, aquifer recharge, or allocations of conserved water.

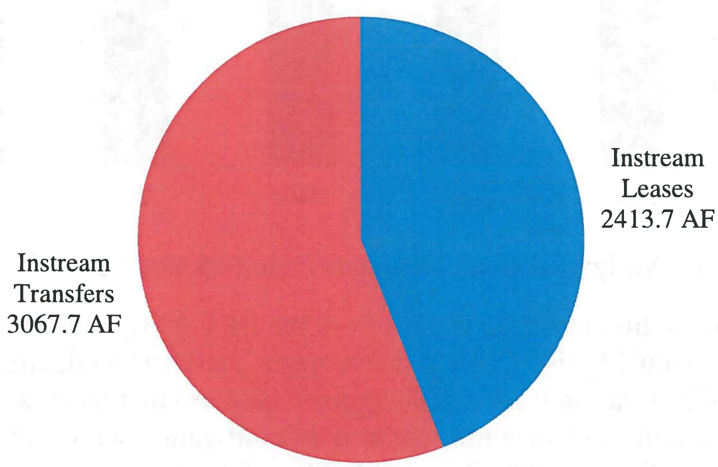


Figure 9. Distribution of total mitigation water in Acre-Feet (AF) between types of mitigation projects in 2012.

In the first five years of the mitigation program, instream leases on average represented 86% of the total volume of mitigation water (in acre-feet) established under the program each year (2003 through 2007). However, in the last five years (2008 through 2012), this has changed. From 2008 through 2012, instream leases have on average represented 50% of the total volume of mitigation water established under the program. While the volume of mitigation water established by instream leases has declined from where it was in 2007 (3710 AF), the annual volume over the last five years has remained fairly steady, around 2100 AF. The amount of mitigation water established through permanent instream transfers has significantly increased annually, lowering the ratio between instream leases and instream transfers. In 2007, the amount of mitigation water established through instream transfers was 848 AF. In 2012, 2413.7 AF of mitigation water had been established through permanent instream transfers.
Figure 10 shows the annual volume of water established through instream leases and instream transfers over the first 10 years of the Mitigation Program.

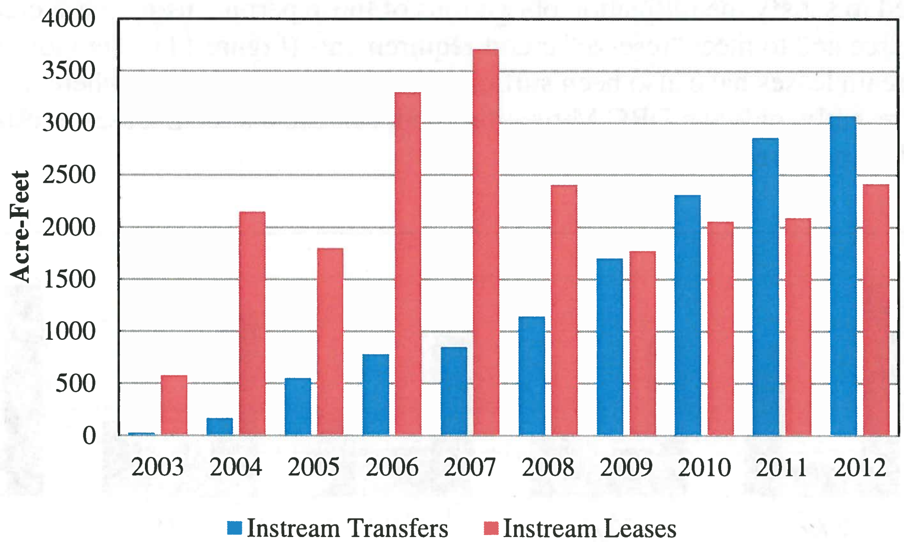


Figure 10. Annual volume of mitigation water established through instream transfers and instream leases in AF.

The primary goal of the mitigation program is to maintain streamflows on an equivalent or more frequent basis. Each new groundwater permit application proposed to OWRD is required to mitigate for the amount of consumptive use that will impact streamflows within a zone of impact. For each mitigation project submitted, the Department identifies the amount of water resulting from the project that can be used for mitigation purposes. OWRD considers the type of use proposed to be converted to instream use, its consumptive use factor (the same as those used to evaluate groundwater permit applications), its priority date, the reliability of its source and other issues that may affect how much consumptively used water can be suspended on an average annual/seasonal basis.

The Department also identifies the zone or zones of impact in which the mitigation water provides instream benefits and may be used for mitigation purposes. This allows for new groundwater appropriations without increasing overall consumptive use that would reduce streamflows within the affected zone of impact.

Instream leases and instream transfers, as mitigation projects, are evaluated similarly. The amount of mitigation water or credits that will be generated by the project is generally based upon the consumptive use that will be suspended and protected instream. For example, one acre of irrigation dedicated to instream use may generally be used to provide mitigation for one new acre of irrigation from a groundwater permit.

Instream Leases

An instream lease is a temporary conversion (for up to five-years) of all or a portion of an existing water use to an instream water right. Since the mitigation program began, each year the amount of temporary mitigation credits generated by instream leases has far exceeded the amount needed to satisfy the mitigation obligations of those permits using these credits as their mitigation source and to meet "reserve" credit requirements (Figure 11). Temporary credits based on instream leases have also been sufficient in each zone of impact where these credits were used. Presently, only the DRC Mitigation Bank can use instream leases to establish temporary mitigation credits.

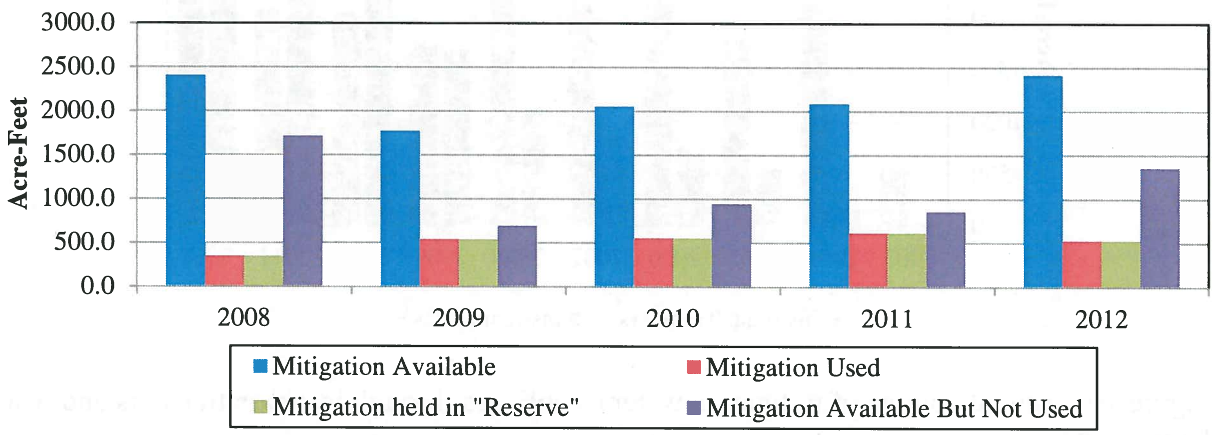


Figure 11. Mitigation established and used through instream leases.

In the first five years of the Mitigation Program, OWRD saw the amount of mitigation established through instream leases increase from 574 AF in 2003 to 3710 AF in 2007. However, in 2008, there was a sharp decrease in the amount of mitigation water established through instream leases (2405 AF). The annual volume of mitigation water established through instream leases since the beginning of the Mitigation Program is shown Figure 10. The decrease in 2008 was, in part, due to planning activities by the DRC Mitigation Bank to more closely match the amount of mitigation established through instream leases to the existing and anticipated demand for temporary mitigation credits.

Within the last five years, the amount of mitigation established through instream leases remained fairly steady at around 2100 AF. The majority of instream leases used to establish mitigation credits continues to be for multiple year periods. However, leases used to establish mitigation in the Whychus Creek and Crooked River Zones of Impact have generally been for periods of one year.

During the last five years of the mitigation program, no issues have been identified affecting the use of mitigation credits created from instream leases. However, OWRD has noticed that a few individual permit holders have failed to maintain or replace their source of mitigation based on instream leases.

The first two of these "delinquent" groundwater permits were identified in 2007. One permit did not provide mitigation for 2 years and was voluntarily cancelled in 2009. The second permit did not provide mitigation for 5 years. The Department, consistent with the Mitigation Program rules, denied an extension request for this permit holder in 2011 and cancelled the permit in 2012 for failure to submit a claim of beneficial use. Both of these permits accounted for 13.2 AF of consumptive use (mitigation obligation). The first permit without mitigation may have been replaced by a transfer of an existing use and the second had not been developed.

Another permit (3.6 AF of consumptive use) failed to provide mitigation in 2008, but was voluntarily cancelled in 2008. In 2012, there were a total of 5 permits without mitigation amounting to 50.1 AF of consumptive use.

The DRC Mitigation Bank has diligently tried to contact any permit holder that did appear to be on track with obtaining annual mitigation from the Bank. A few of these permit holders have reestablished mitigation with the Bank, while a few, as noted above have not. Figure 12 shows the annual volume of mitigation obligations not satisfied with a mitigation source, by the zone of impact.

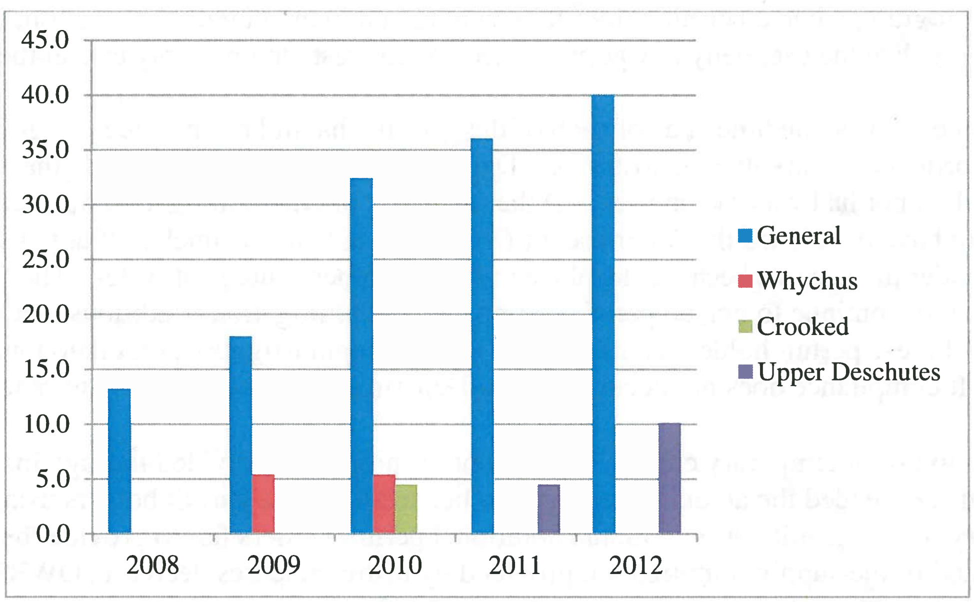


Figure 12. Annual mitigation in AF not provided by permit holders using instream leases as their mitigation source, by zone of impact.

Figure 13 shows the number of permits not providing the required mitigation on an annual basis.

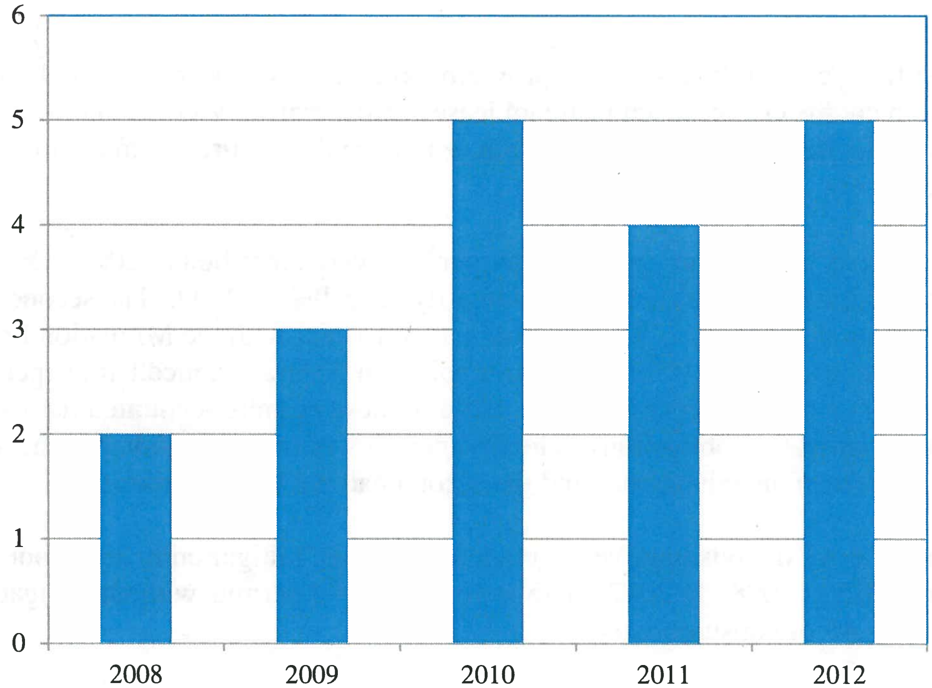


Figure 13. Number of permits without mitigation.

Since groundwater permit holders using temporary mitigation credits (instream lease based mitigation) from the DRC Mitigation Bank need to obtain mitigation credits on an annual basis, there is the risk of groundwater users failing to obtain the required mitigation. Under the Mitigation Program, when a permit holder fails to maintain their source of mitigation, OWRD is required to regulate the use, deny any permit extension request, and possibly cancel the permit.

The Department has visited the sites of each of the permits that did not provide mitigation in 2012. The primary use involved is irrigation. Department staff identified that (1) the well had not been drilled nor had water been used, (2) that the users provided mitigation initially but did not appear to have developed the water use, or (3) in two cases it was unclear if any water had been used under the permits because the place of use had other sources of water. The Department will continue to pursue permit compliance with mitigation conditions. However, should any of these permit holders continue to irrigate or begin irrigating, regulation will be necessary. If compliance does not occur, then the Department will need to pursue cancellation.

With regard to use of temporary credits, the amount of mitigation provided through instream leases has also exceeded the amount of mitigation needed for those permit holders using this as their primary source of mitigation. Should additional permit holders fail to provide the required mitigation and/or the supply of mitigation provided by instream leases decrease, OWRD may need to evaluate how instream leases are used for mitigation purposes.

Permanent Instream Transfers

Any groundwater permit applicant or other individual can use permanent instream transfers to generate mitigation credits. As the mitigation program has grown, the number of mitigation projects submitted involving instream transfers has increased steadily each year (Figure 14).

Mitigation credits generated from projects based upon instream transfers are permanent in nature. Water is permanently protected instream as a result of the completion of an instream transfer application, resulting in a new instream water right. As compared to instream leases, use of these types of credits by a groundwater permit holder does not require any ongoing maintenance of credits.

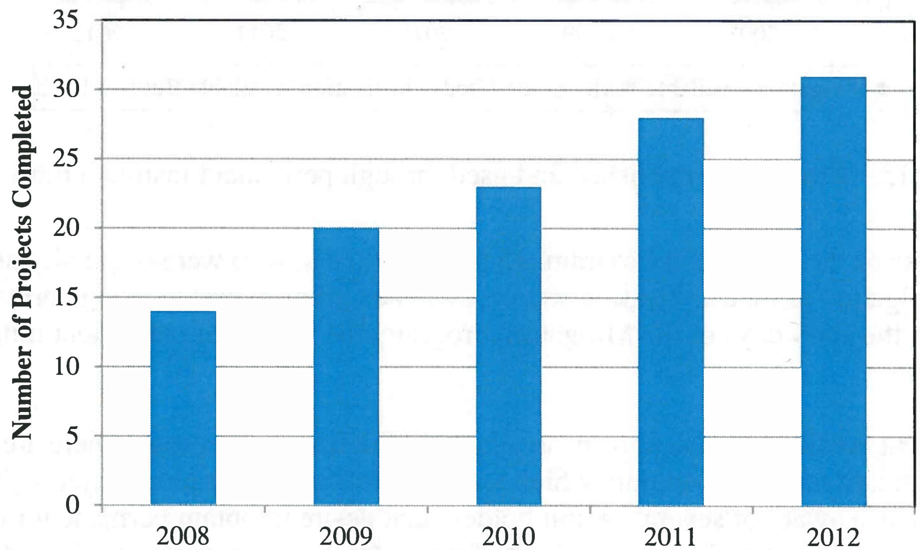


Figure 14. Cumulative number of mitigation projects involving permanent instream transfers.

In the last five years of the Mitigation Program, as in the first five years, not all of the mitigation established by instream transfers has been used to provide mitigation to new groundwater permits (Figure 15). Some of this mitigation water has remained available. As groundwater permit applications continue to be processed through to permit, more of this mitigation water will be used.

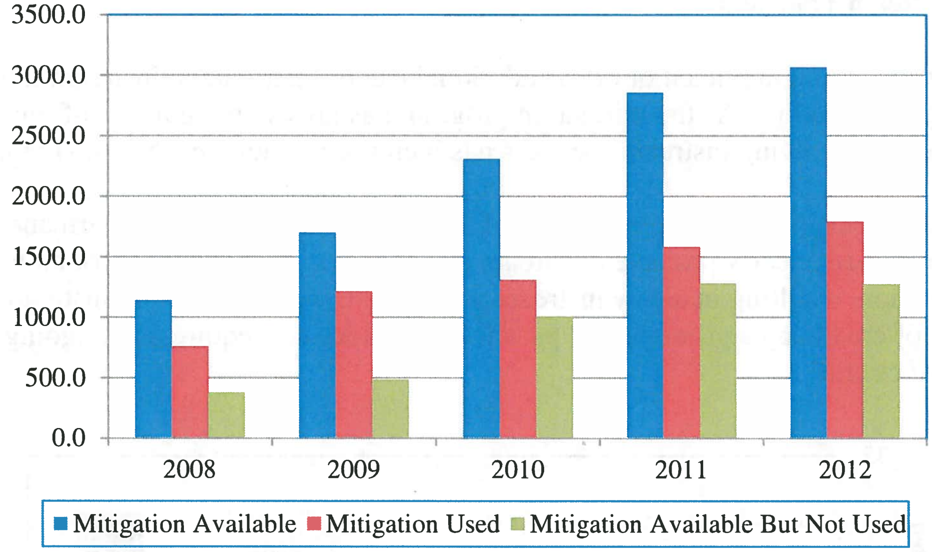


Figure 15. Mitigation established and used through permanent instream transfers.

Over the course of the Mitigation Program, 15 permit holders, who were originally using temporary mitigation as their mitigation source, switched all or in part to using permanent mitigation. In the early days of the Mitigation Program, the supply of permanent mitigation water was less.

More permanent credits will also become available in the future. Presently, there are 13 permanent instream transfers pending, which are also proposed mitigation projects. The Department is also aware of several permit holders that desire to obtain permanent mitigation and will likely switch mitigation sources in the future. Of the four certificates issued by the Department, all have permanent mitigation as their mitigation source.

Aside from application of new instream transfers, another mechanism under which additional permanent credits may become available in the future, is through cancellation of a permit. However, the Division 522 rules limit the type of cancellation process under which a permit may be cancelled and any permanent credits assigned to it can be reassigned to another permit. Division 522 identifies permits cancelled under ORS 537.410, which is a little used cancellation process. As previously noted, the rules do not include other cancellation processes, including voluntary cancellation of a permit. One of the four permits cancelled through 2012 has 9.0 AF of permanent mitigation assigned that cannot be reassigned to another permit.

Allocation of Conserved Water

No Allocation of Conserved Water Projects have been submitted to the Department proposing to generate mitigation in the Deschutes Groundwater Study Area. An allocation of conserved water is the reduction in the amount of water diverted to satisfy an existing beneficial use by improving the method of transporting or applying the water, with all or a portion of the conserved water going to instream use.

In 2010, one of the irrigation districts in the Deschutes Basin asked the Department to look at whether a canal lining or piping project could be used to generate mitigation. After careful consideration, OWRD identified that it appeared unlikely that it would be able to approve an Allocation of Conserved Water Project involving canal lining for mitigation purposes and continue to meet the goal of the mitigation program. As previously identified earlier in this report, there is a direct interaction between surface water and groundwater in the Deschutes Basin. Although the effect of groundwater use on surface water flows is attenuated, the eventual effect of a new use is year round. Infiltration of surface water into groundwater from the irrigation district canal systems discharges back to surface water flows on a year round basis. Instream rights created from an Allocation of Conserved Water Project based on irrigation rights result in instream flows during the irrigation season. Putting canal water back into the river system during the irrigation season would cause a reduction in flows during the winter months. In addition, conserved water from a canal lining or piping project is not consumptively used. Thus, using these types of instream flows to mitigate for the impacts of a new consumptive groundwater use in the basin would result in an additional decrease in streamflows.

Aquifer Recharge

One mitigation project has been proposed to OWRD involving an aquifer recharge project. This project was submitted to the Department in 2000. In 2006, OWRD issued a Proposed Final Order proposing to deny the application. This project application has been protested by the applicants, and the applicants continue to work with OWRD to resolve the issues raised.

During the review process, OWRD determined that on its own, an aquifer recharge project does not result in mitigation water, because an aquifer recharge project does not protect water instream. All mitigation projects must result in water that can be protected instream. However, it may be possible for a secondary application appropriating water from the project for the purpose of flow augmentation to result in water that could be protected instream. Should this application move forward, OWRD will need to evaluated whether instream flows resulting from an aquifer recharge project generate mitigation water.

Other Mitigation Project Types

To date, no mitigation projects have been proposed to the Department involving time-limited instream transfers. Time-limited instream transfers differ from instream leases in that they can be issued for any length of time specified in the application.

One other potential type of mitigation project identified in the Mitigation Program Rules, is the use of a secondary permit to use stored water from an existing reservoir for instream use. To date, no secondary rights have been obtained to use stored water from an existing reservoir for instream use and mitigation. However, in the last couple years of the mitigation program (2011 and 2012), the Department has approved two mitigation projects (instream leases) involving, in part, the release of stored water from an existing reservoir. Both of these projects involved the temporary conversion of a portion of an existing secondary right that allows both the use of live flow and release of water from a reservoir for instream use under an instream lease. Both projects also involve the conversion of an existing consumptive use to instream use. The consumptive portions of each right were used to establish mitigation. For each project, the live flow and stored water were used instream in conjunction. Once live flow was no longer available under the portion of the right leased to instream use, water was released from storage and protected instream.

Zone of Impact Evaluation

As part of the five-year evaluation, the WRC is required to evaluate the zones of impact identified by OWRD. This evaluation may include analysis of where the zones are located, whether adequate zones are identified, and whether the mitigation program is doing an effective job of distributing mitigation water to the affected stream reaches within each zone of impact.

Groundwater users with permits issued under the mitigation program are required to provide mitigation within the DGWSA and in a zone of impact identified by the Department (Figure 16). The red boundary shown on the map is the boundary of the DGWSA (USGS Study Area) and the shaded and hachured areas are the zones of impact. The purpose of these zones of impact is to target mitigation in and above stream reaches, on a subbasin level, where impacts on streamflows by groundwater pumping are expected to occur. Mitigation projects establish mitigation water within at least one zone of impact and may establish mitigation in more than one zone. Multi zone projects result in water that would benefit streamflows in each zone of impact identified.

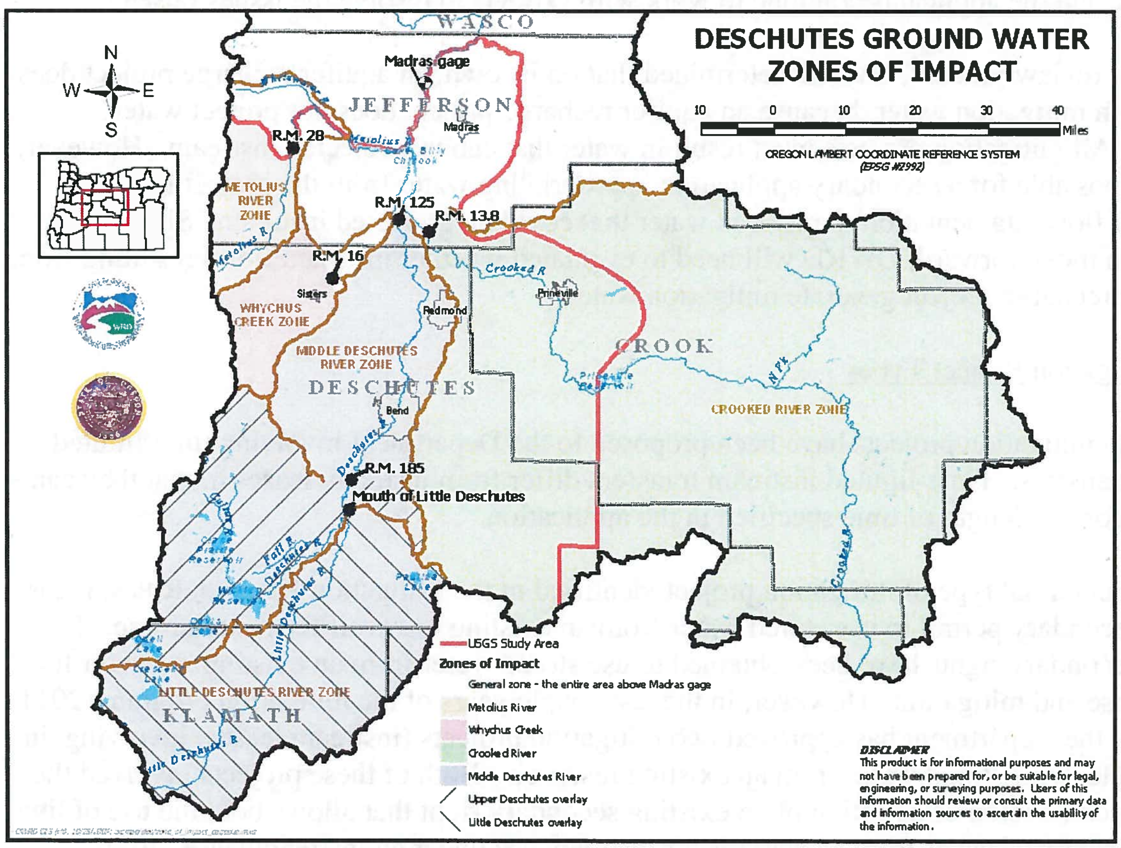


Figure 16. Map showing the location of each zone of impact identified by OWRD.

As demonstrated in Figure 17, the majority of new groundwater uses were found to have an impact on the General Zone of Impact. The number and quantities associated with permits for each zone of impact is shown in Table 1.

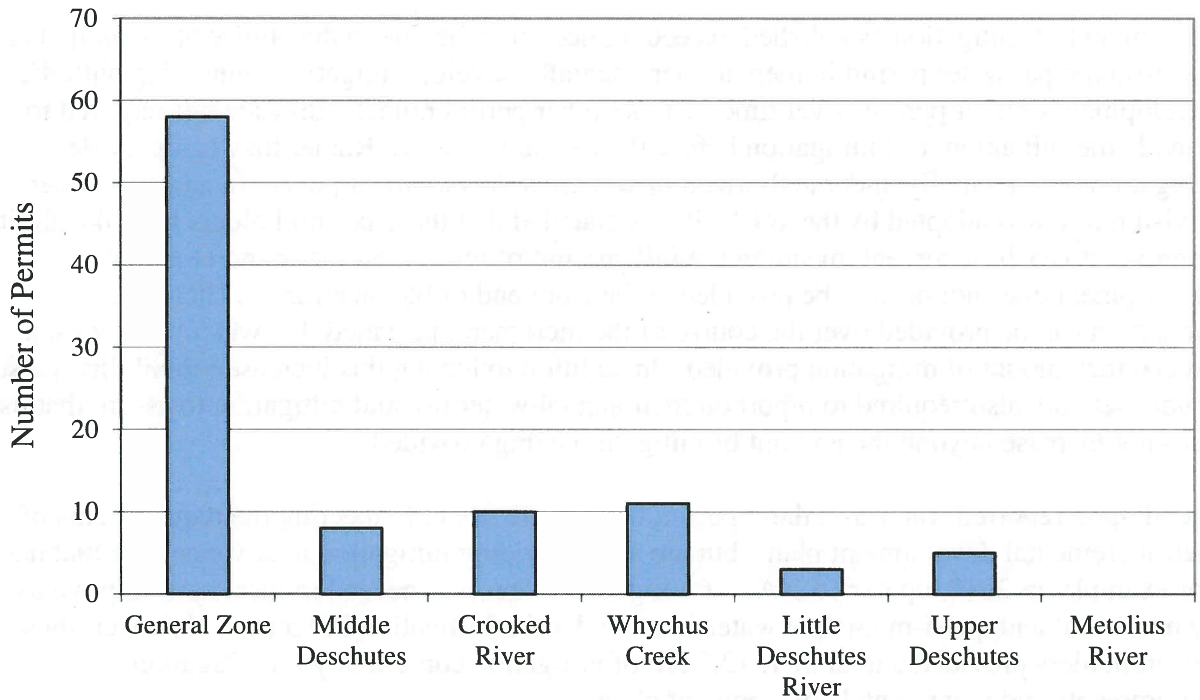


Figure 17. Number of groundwater permits issued by zone of impact by end of 2012.

Table 1. Summary of groundwater permits by zone.

Zone of Impact	Number of Permits	Rate () Approved by Permit	Maximum Volume (AF) Approved by Permit	Total Mitigation Obligation (AF)
General	58	67.3	12,746.4	6,370.2
Middle Deschutes	8	0.92	221.5	129.8
Crooked River	10	14.80	5,680.7	2,385.5
Whychus Creek	11	4.40	1,213.7	585.5
Little Deschutes	3	0.48	368.3	13.2
Upper Deschutes	5	0.29	76.8	46.1
Metolius River	--	--	--	--
Totals	**95**	**88.2**	**20,307.4**	**9,530.3**

During all 10 years of the Mitigation Program, more mitigation than needed for each new groundwater use has been provided in the appropriate zones of impact as described below.

In the early years of the Mitigation Program, mitigation was being established faster than new permits were being issued. Over the last five years, OWRD has issued six new permits each year on average. Mitigation projects are still being proposed and establishing mitigation in advance of new permits being issued in each of the zones of impact. This is, in part, to meet expected need for mitigation by pending applications. At the end of 2012, there were 40 applications pending that will need mitigation before permits may be issued.

The amount of mitigation established exceeding need may be due to the ability of municipal and quasi-municipal water permit holders to incrementally develop mitigation coinciding with the development of their permits over time. Unlike other permit holders, they are not required to provide the full amount of mitigation before the permit is issued. Rather they can provide mitigation incrementally under authorized incremental development plans. In addition, when Division 522 was adopted by the WRC, it was clarified that these permit holders have the ability to grow into each increment, meaning the full amount of mitigation for an increment of development does not need to be provided at the front end of the increment. Therefore, mitigation can be provided over the course of the increment, provided that water use does not exceed the amount of mitigation provided. In addition to having this increased flexibility, these water users are also required to report on their annual water use and mitigation to assure that use does not increase beyond the amount of mitigation being provided.

Based upon reported water use, these permit holders are not only meeting the requirements of their incremental development plans, but are also providing mitigation in advance of actual need. For example, in 2012, up to 615.9 AF of mitigation water was needed to meet consumptive use by municipal and quasi-municipal water users under the Mitigation Program. However, these permit holders provided a total of 1312.5 AF of mitigation consistent with mitigation requirements and incremental development plans.

The source of mitigation in each zone of impact has been instream leases and permanent instream transfers. In total, just over 51 cfs and 13,993.2 AF (2012) has been protected instream as a result of mitigation projects within the DGWSA. Only a portion of the volume of water protected instream has been identified by OWRD as available for mitigation purposes. The total volume of mitigation by end of 2012 was 5481.4 AF.

Based upon this evaluation, it appears that the zones of impact identified by the Department are addressing mitigation needs within the DGWSA. A need for additional zones has not been identified but will continue to be examined.

<u>General Zone</u>: Groundwater applicants identified by OWRD as needing to provide mitigation in the General Zone are impacting flows in the confluence area between the Deschutes River, the Crooked River and the Metolius River where groundwater is discharging to surface water through a large spring system. Therefore, these permit applicants are required to provide mitigation that benefits streamflows in this area. The point above which water must be protected instream to result in mitigation for these permit applications is the Madras Gage, located approximately at River Mile 100.1.

Most of the mitigation water available in the General Zone of Impact originated in other upstream zones. Many of these mitigation projects have protected instream flows through the middle reach of the Deschutes River (Middle Deschutes Zone of Impact) and down to Lake Billy Chinook, at approximately River Mile 120 (Figure 14), above the confluence area. Other projects originate in the Little Deschutes River (Little Deschutes Zone of Impact), which enters the Deschutes River just downstream from River Mile 193. In 2012, approximately 27.48 cfs and 8736.5 AF were protected through the Deschutes River and down to Lake Billy Chinook.

There are, however, a few of the mitigation projects that established mitigation credits in the General Zone that did not protect water instream into the Deschutes River and down to Lake Billy Chinook but still provided instream benefits. For example, projects on Whychus Creek protected flows only to the mouth of Whychus Creek. While instream flows are not protected into the mainstem Deschutes River, the flows in the Deschutes River at the confluence with Whychus Creek are at such a high level that there is still an instream benefit even considering downstream users. In 2012, approximately 4.2 cfs and 906.8 AF were protected in Whychus Creek where mitigation also benefited flows in the General Zone.

Another project is one that originated on Snow Creek, which is located above Whychus Creek. However, Snow Creek does not flow into downstream waters. Rather, the creek submerges and contributes to groundwater. The Department identified that water from the creek likely discharges to surface water in the area of the confluence between the Deschutes River, Crooked River and Metolius River above the Madras Gage. This project resulted in 0.757 cfs and 151.5 AF protected instream.

Of the water protected instream, only a portion is used to establish mitigation. For example, based on 2012 numbers, approximately 9643.3 AF was protected instream where mitigation was established in the General Zone but only 4452.4 AF of that was identified as mitigation. And not all 4452.4 AF were used for mitigation. Some remained instream. In each year of the mitigation program, more water is protected instream than dedicated to use as mitigation.

As identified above, most mitigation projects in the General Zone originated in upstream zones of impact. This along with urbanization has likely lead to the steady supply of mitigation water in this zone. The General Zone encompasses an area supplied by large irrigation districts, expanding urban areas, and surface water rights that are more easily transferred or leased instream for mitigation purposes as the use of water changes from agricultural to urban purposes.

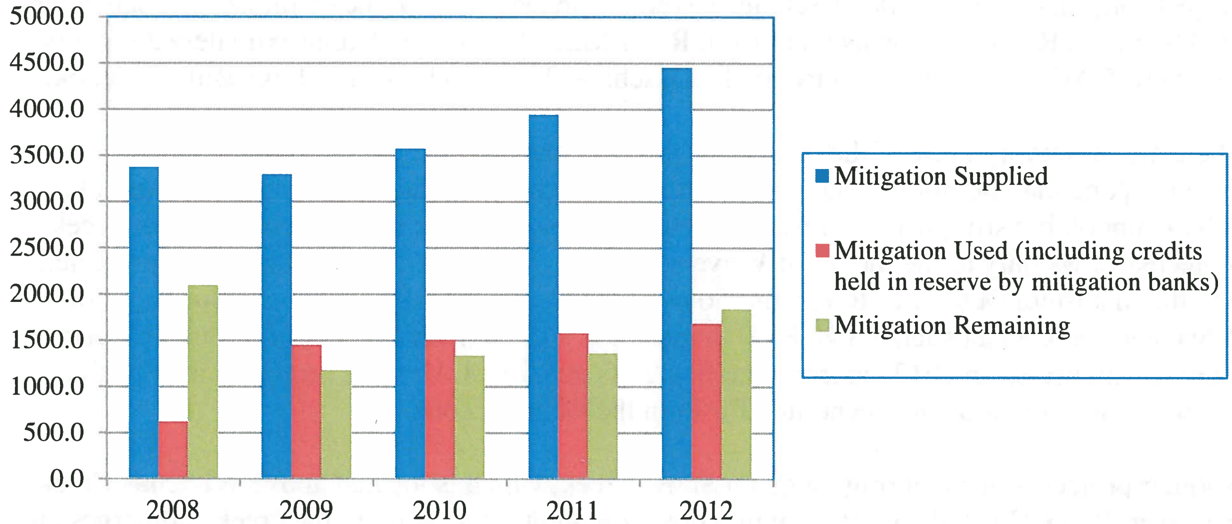


Figure 18. Total mitigation supplied and used in the General Zone of Impact.

As shown in Figure 18, more mitigation is established (supplied) each year in the General Zone of Impact than needed to meet use by groundwater permit and certificate holders with mitigation obligations.

Within the General Zone of Impact, the mitigation obligation at full build out, without accounting for incremental development, under all existing permits and certificates issued up through 2012 will be 6200 AF. However, municipal and quasi-municipal permit holders account for 5701 AF (92%) of the full mitigation obligation. In 2012, the maximum mitigation obligation, accounting for incremental development, for all permits and certificates in the General Zone was just over 1600 AF, as shown in Figure 19. This is in contrast to the almost 4500 AF of mitigation established in the General Zone as shown in Figure 18.

In each year of the mitigation program there has consistently been a remaining balance of over 1000 AF of mitigation not assigned to any permit or certificate. In addition, based upon reported water use levels for municipal and quasi-municipal permit holders and anticipated use by other permit holders, it's estimated that up to 856 AF of water may have been consumptively used in 2012. But as shown in Figure 18, almost 1700 AF of mitigation was assigned to permits and certificates under the Mitigation Program in 2012 and considered used. Of the mitigation considered used, 297 AF was held in reserve by the DRC Mitigation Bank. There was then approximately 1400 AF of mitigation assigned to permits/certificates in the General Zone but not necessarily needed yet considering estimated consumptive use.

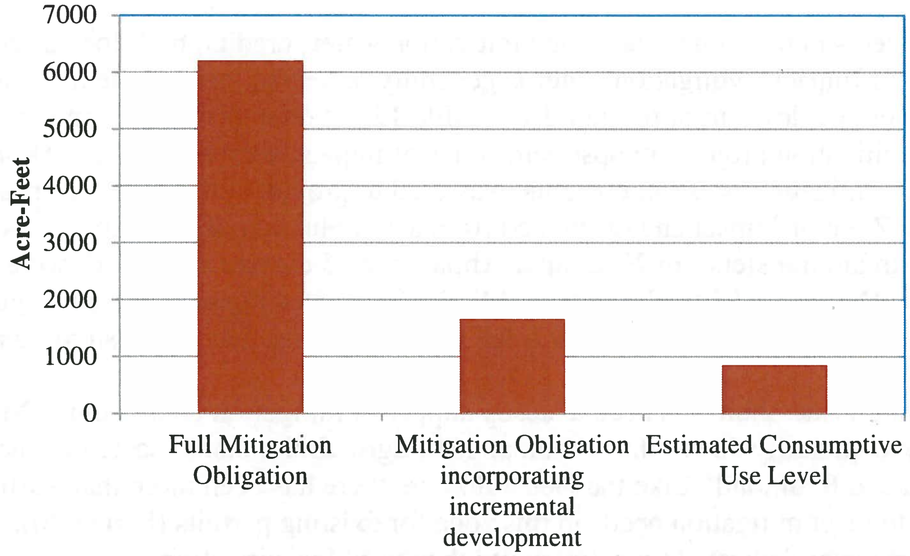


Figure 19. Full Mitigation Obligation, Mitigation Obligation (accounting for incremental development), and estimated amount of water consumptively used in 2012 in the General Zone of Impact.

In each year of the Mitigation Program, in the General Zone of Impact, the amount of mitigation provided and considered used exceeds the estimated amount of consumptive use that may be occurring within this zone.

During 2008 through 2012, OWRD identified an issue not addressed in the previous five-year evaluation of the Mitigation Program. When evaluating groundwater permit applications for impacts on surface water flows and identifying their mitigation obligation (zone of impact and amount of mitigation required), the Department has also identified when the proposed groundwater use may impact surface water flows where the impact may not be mitigated under the Mitigation Program. This issue first arose on a groundwater permit application in the Whychus Zone of Impact in the early days of the mitigation program and has been further evaluated by OWRD as an issue that affects zones of impact and the location of mitigation. For example, in 2007, OWRD evaluated a permit application that was identified as impacting flows on Tumalo Creek. The zone of impact for the application was the General Zone. However, OWRD staff identified that unless mitigation was provided in Tumalo Creek itself, mitigation provided in the General Zone, which is generally through the mainstem Deschutes River, would not mitigate for impacts to Tumalo Creek. This permit application was ultimately denied in 2008 due to potential injury to surface water rights on Tumalo Creek. This approach has also been taken in other zones of impact to protect senior water rights, including instream water rights, and downstream scenic waterway flows.

<u>Middle Deschutes</u>: Groundwater applicants identified by OWRD as needing to provide mitigation in the Middle Deschutes Zone are impacting flows in an area on the mainstem Deschutes River above River Mile 125 that is vulnerable to interference by groundwater use and where instream rights are not being met. Therefore, these permit applicants are required to provide mitigation that benefits streamflows above this area.

Mitigation projects in this zone established mitigation water (credits) both for this zone and the General Zone of Impact. Mitigation water is generally protected through the mainstem Deschutes River and down to or through River Mile 125. Some mitigation water was also generated by mitigation projects in upstream zones of impact, such as the Little Deschutes. The majority of the mitigation water in this zone was used to provide mitigation for groundwater use in the General Zone of Impact and originated from a combination of instream leases and permanent instream transfers. In 2012, approximately 27.5 cfs and 8736.5 AF were protected instream in the Deschutes River through the Middle Deschutes Zone of Impact (Figure 16). Of the water dedicated to instream use, 2949.6 AF was actually used to establish mitigation.

Like the General Zone, there has been a steady supply of mitigation credits in the Middle Deschutes Zone, partially due to the urbanization of agricultural lands located in and around the cities of Bend and Redmond. Like the General Zone, there has been more than sufficient supply of mitigation to meet mitigation needs in this zone for existing permits (Figure 20). There has also been more water dedicated to instream use than used for mitigation.

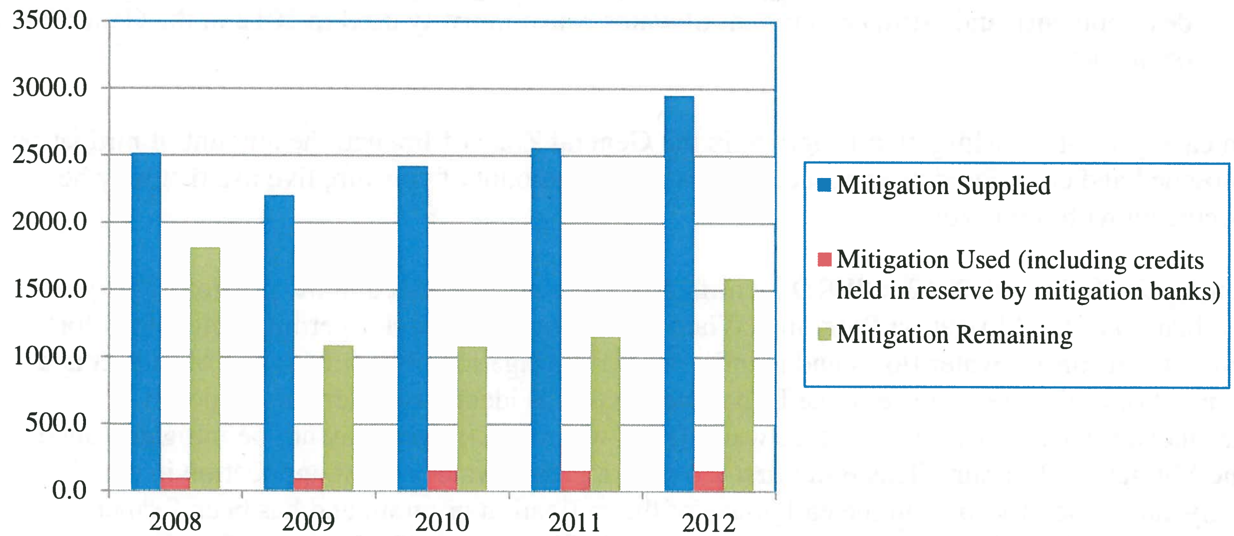


Figure 20. Total mitigation supplied and used in the Middle Deschutes Zone of Impact.

In the previous five-year evaluation, it was identified that only five new groundwater permits have been approved in this zone. As of year-end 2012, there are now 8 groundwater permits in the Middle Deschutes Zone of Impact with a full Mitigation Obligation of 129.8 AF. There are no municipal or quasi-municipal permit holders in this zone of impact. All 8 permits are for irrigation use and the full mitigation obligation was required to be provided before each of the permits was issued. The primary mitigation source for permits in this zone is permanent mitigation projects, 102.8 AF of mitigation. Again, like in the General Zone, it also appears the mitigation is being established in advance of need, given the remaining supply of mitigation as shown in Figure 20.

As of year-end 2012, there were no additional permit applications pending that had a mitigation obligation identified as being within the Middle Deschutes Zone of Impact. No issues have been identified as affecting mitigation or how mitigation is provided within this zone of impact.

Whychus Creek: Groundwater applicants identified by OWRD as needing to provide mitigation in the Whychus Creek Zone are impacting flows in Whychus Creek. Whychus Creek is vulnerable to interference by groundwater use and instream water right flows are not met throughout the subbasin. Mitigation needs to be provided above River Mile 16 on Whychus Creek to target mitigation water above this point, which is located just below a set of springs (groundwater discharge area) and where groundwater is no longer interfering with Whychus Creek.

The amount of mitigation water generated in the Whychus Zone generally continues to increase each year. Several mitigation projects in this zone of impact also generated mitigation water in the General Zone of Impact. Mitigation water is protected, for the most part, in Whychus Creek beginning at a point above River Mile 16 and down to the mouth of the creek. More water is dedicated to instream use than used to generate mitigation. In 2012, approximately 6.46 cfs and 1514.6 AF were protected instream under mitigation projects in this zone of impact. However, only 655.4 AF was available for use as mitigation.

Mitigation water in this zone has primarily originated from instream leases, which have generally been for one year periods, through the Three Sisters Irrigation District. However, there is one instream lease that has been in place since 2005. Only two instream transfers have been used to establish permanent mitigation in this zone. However, there are another three instream transfers pending that may result in additional permanent mitigation in this zone of impact.

Temporary mitigation was used by groundwater permit holders in both the Whychus Creek and General Zones of Impact. Permanent mitigation was used only in the Whychus Creek Zone.

Generally, there are fewer opportunities to generate mitigation water in this zone of impact and continued increase in supply of mitigation water is less certain than in the Middle Deschutes and General Zones of Impact. Land use in the Whychus Creek Zone of Impact tends to be more agricultural based and there is less urbanization. However, to date, mitigation supply has continued to exceed the amount of mitigation needed and used by permit holders (Figure 21), although only by a small amount. In each year (2008 through 2012), there were less than 100 AF of mitigation remaining.

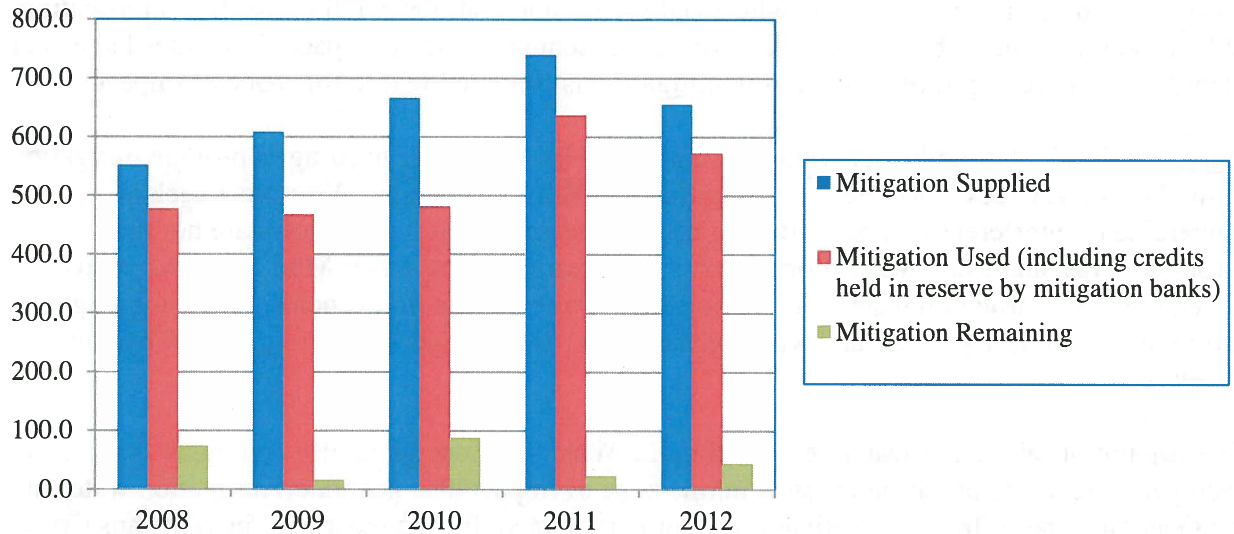


Figure 21. Total mitigation supplied and used in the Whychus Creek Zone of Impact.

Most of the mitigation used in 2012 was from temporary mitigation (instream leases) in the amount of 171.2 AF. The DRC Mitigation Bank was required to keep another 171.2 AF of mitigation in reserve. These credits are identified as used in OWRD's accounting of mitigation availability. There was an additional 230.3 AF of permanent mitigation assigned to permits in the Whychus Creek Zone of Impact. Out of the 655.4 AF of credits supplied in this zone, 572.0 AF of them were considered used, including reserved credits. Figure 21 reflects this low supply of remaining mitigation.

However, mitigation is also being established and assigned to permits ("used") in advance of need. In each year of the mitigation program, the amount of mitigation used is more than the amount of mitigation needed based on estimated consumptive use levels. In the Whychus Creek Zone of Impact, there are 10 permits and 1 certificated use issued under the Mitigation Program. With the exception of a permit issued to the City of Sisters for municipal use, all uses in this zone are for irrigation. The City is providing mitigation under an incremental development plan and required to report their annual use for each calendar year. In 2012, estimated consumptive use, based upon reported water use from the City of Sisters and anticipated consumptive use by other permit/certificate holders, was almost 350.0 AF.

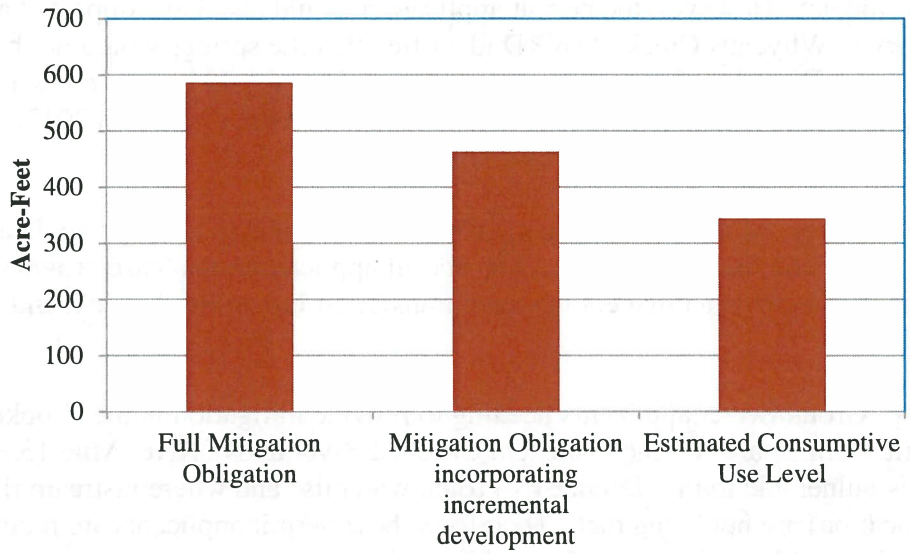


Figure 22. Full Mitigation Obligation, Mitigation Obligation (accounting for incremental development), and estimated amount of water consumptively used for 2012 in the Whychus Creek Zone of Impact.

In the Whychus Creek Zone of Impact an alternative to mitigation is also being used. Under the Mitigation Program, permit applicants can offset their impacts on surface water flows in full or in part by cancelling another groundwater right with similar impacts on surface water flows. Municipal and quasi-municipal permit holders may also incorporate an "offset" as part of their incremental development plans. The amount of impact offset by the cancellation of existing groundwater rights by municipal and quasi-municipal permit holders in 2012 was 23.4 AF. When combined with the amount of mitigation used, this totals 596.1 AF.

Even when reserve mitigation is factored in, the amount of mitigation and "offset" provided and considered used exceeds the estimated amount of consumptive use that may be occurring within this zone.

At the end of 2012, there were an additional 6 groundwater applications pending with a potential mitigation demand of 104 AF. As previously noted, the remaining balance of mitigation at the end of each calendar year has been approximately 100 AF, and there are 3 permanent mitigation projects pending that may establish additional mitigation in this zone of impact.

As previously noted under the General Zone of Impact, when evaluating groundwater permit applications, OWRD also considers impacts that a proposed use may have on other stream reaches within the zone of impact and whether mitigation will offset those impacts. This issue was also identified in the Whychus Creek Zone of Impact.

In 2007, OWRD evaluated a groundwater permit application that was identified as impacting surface water flows where impacts could not be mitigated. This particular application was part of an exchange that was expected to result in flow augmentation within Whychus Creek. It was a non-consumptive use and would have had a mitigation obligation of 0.0 AF in the Whychus

Creek Zone of Impact. However, the permit application would also have impacted a set of springs tributary to Whychus Creek. OWRD identified that the springs would not benefit from augmented flows in Whychus Creek and rights on the springs would be injured as a result. OWRD proposed to deny the application in a Proposed Final Order issued in 2012. The application was later withdrawn by the applicants.

In the early years of the Mitigation Program, OWRD also evaluated a permit application that would impact flows in Indian Ford Creek. The permit applicant in that case provided a mitigation project through a permanent instream transfer on Indian Ford Creek, and has been issued a certificate.

Crooked River: Groundwater applicants needing to provide mitigation in the Crooked River Zone impact flows in an area on the mainstem Crooked River above River Mile 13.8 (at Osborne Canyon) that is vulnerable to interference by groundwater use and where instream rights (pending application) are not being met. Therefore, these permit applicants are required to provide mitigation that benefits streamflows above this area.

Water dedicated to instream use under a mitigation project is protected instream through the Crooked River to River Mile 13.8 and down to the confluence with Lake Billy Chinook. This includes both instream leases and instream transfers. The total amount of water dedicated to instream use in the Crooked River during 2012 was approximately 5.1 and 1570.2 AF. Only a portion of the water dedicated to instream use is used for mitigation. In 2012, 799.3 AF out of the 1570.2 AF dedicated to instream use could be available to mitigate for new groundwater uses under the Mitigation Program.

During the first five years of the Mitigation Program, the amount of mitigation water generated in the Crooked River Zone of Impact had fluctuated each year with no mitigation water available in the first year (2003). Mitigation water in this zone of impact has generally been more difficult to establish. However, over the last five years of the Mitigation Program, the amount of mitigation generated in the Crooked River Zone has steadily increased. Mitigation is also being established in advance of need. Mitigation projects in this zone also generated mitigation water in the General Zone of Impact. Mitigation water was used by groundwater permit holders in both zones.

In 2008 and 2009, there was only one instream lease being used for temporary mitigation annually in the Crooked River Zone of Impact from North Unit Irrigation District (NUID). In 2010, the City of Prineville and another private landowner also submitted instream leases that were used to establish mitigation. In 2011, only a single lease from NUID was used to establish mitigation in this zone. In 2012, four instream leases were used to establish mitigation, which included one from NUID and 2 from Ochoco Irrigation District (OID). 2012 was the first year that OID with the DRC Mitigation Bank had proposed to use their leases to establish mitigation in the Crooked River Zone of Impact.

The primary contributor to the increase in mitigation supply is permanent instream transfers. By the end of 2012, there were 5 permanent mitigation projects with 515.6 AF of mitigation. Only one of these projects was targeted toward a specific groundwater permit application. The rest of the mitigation was available to other permit holders and applicants.

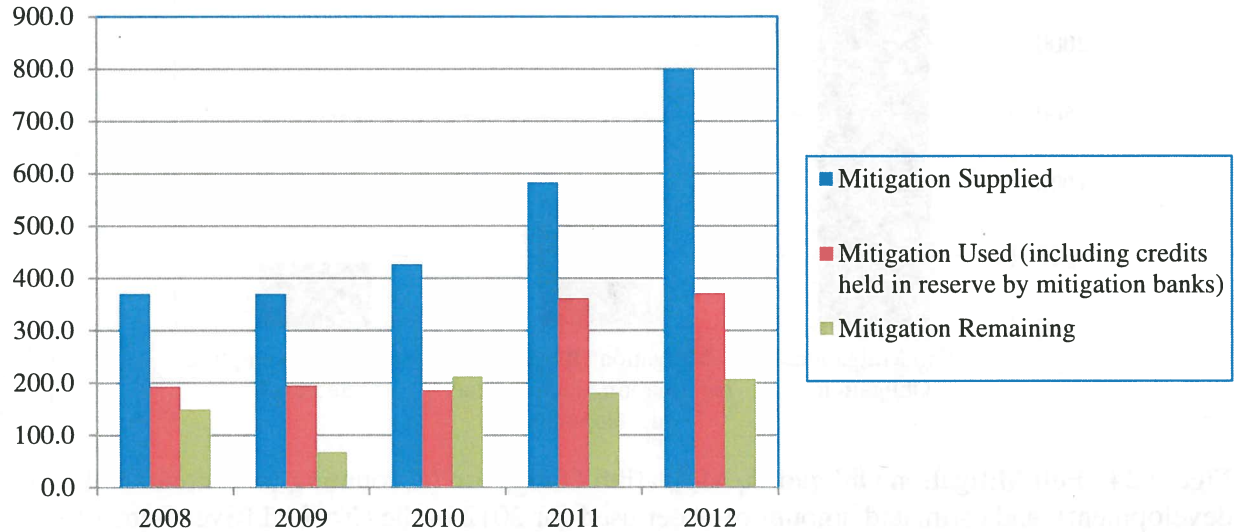


Figure 23. Total mitigation supplied and used in the Crooked River Zone of Impact.

The primary water users in the Crooked River Zone of Impact are municipal and quasi-municipal. There are 8 groundwater permits and 2 certificates in the Crooked River Zone of Impact and 4 of those are for municipal and quasi-municipal water use. Of the full mitigation obligation in this zone (2385.5 AF), the municipal and quasi-municipal permit holders account for 91%. All four municipal and quasi-municipal permit holders are providing mitigation under incremental development plans and do not need to provide the full amount of mitigation all at once.

If all permit and certificate holders were using up to the full amounts authorized, the amount of mitigation available would be insufficient. In 2012, only up to 800 AF of mitigation was available for use (Figure 23). But the amount of mitigation used in the Crooked River Zone itself was 371.3 AF, which includes 10.1 AF of mitigation credits held in reserve. This reflects incremental development by the municipal and quasi-municipal permit holders. The municipal and quasi-municipal permit holders are also taking advantage of the "offset" option in the Crooked River Zone of Impact. The amount of impact offset by the cancellation of existing groundwater rights by municipal and quasi-municipal permit holders in 2012 was 331.8 AF. When combined with the amount of mitigation used, this is 703.1 AF of used mitigation and "offset."

However, the estimated amount of water that may have been consumptively used, as shown in Figure 24, may only have been up to 462.9 AF, which is well within the range of the amount of mitigation available and "offsets" within this zone. Mitigation remaining at the end of each calendar year, as shown in Figure 23, is available for additional or future mitigation demands. For example, in 2012, municipal and quasi-municipal permit holders provided almost 50% more mitigation than needed to meet their identified amount of consumptive use.

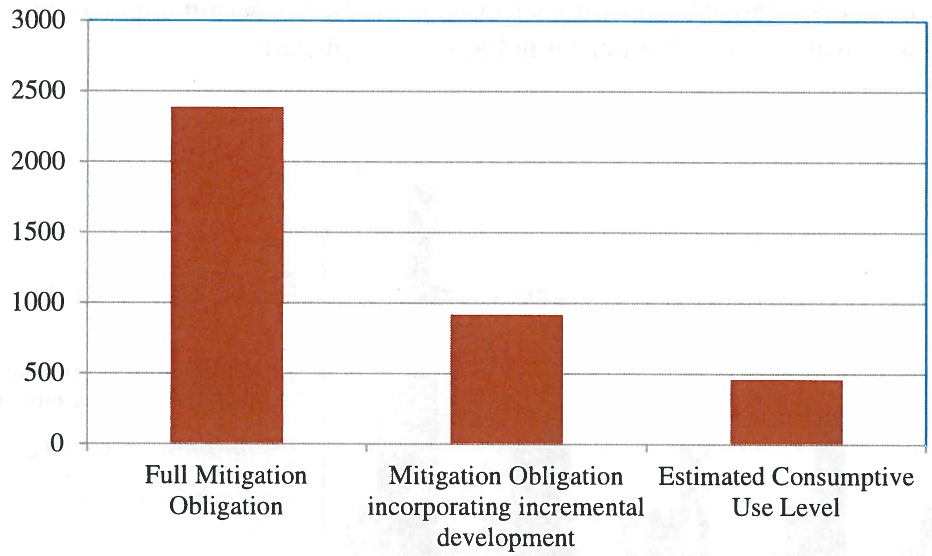


Figure 24. Full Mitigation Obligation, Mitigation Obligation (accounting for incremental development), and estimated amount of water used for 2012 in the Crooked River Zone of Impact.

At the end of 2012, there were 4 pending groundwater applications that will need additional mitigation, up to 1251 AF. This exceeds the remaining balance of mitigation shown in Figure 23. However, two of these pending applications are for quasi-municipal water use and may not need to provide the full amount of mitigation prior to the permit being issued if they opt to provide mitigation under incremental development plans. The amount of water available for use as mitigation in the Crooked River Zone has increased annually through instream leases and instream transfers. In addition, there is an instream transfer pending that may generate additional permanent mitigation in this zone.

When evaluating groundwater permit applications, the Department identifies a single zone of impact in which the groundwater use, if approved, must provide mitigation. However, in 2010, the Department identified a groundwater use that would have two zones of impact. This was a permit application submitted by the City of Prineville. The City proposed to use eight wells to supply the requested municipal use. However, the wells were located in very different geographic locations. Six of the wells were found to impact streamflows in the Crooked River Zone of Impact and two were found to impact streamflows in the General Zone of Impact. The City is required to report both its annual water use and the amount of water used in each zone of impact. The permit for this use was issued in 2011. Water was only used in the Crooked River Zone of Impact during 2011 and 2012.

Within the first five years of the Mitigation Program, the Department identified that mitigation was more difficult to develop in this zone. However, over the last five years, the amount of mitigation available has continued to increase annually. There is presently one mitigation project pending in the Crooked River Zone that may result in additional mitigation.

Little Deschutes River: Groundwater permit applicants needing to provide mitigation in the Little Deschutes Zone impact flows in an area on the mainstem Little Deschutes River above the mouth of the river. The Little Deschutes River above its mouth is vulnerable to groundwater interference and instream flows are not met. Therefore, these permit applicants are required to provide mitigation that benefits streamflows in the Little Deschutes River above the mouth. There are also several tributaries in the upper reaches of the Little Deschutes subbasin that are vulnerable to groundwater interference as well.

Mitigation projects within this zone of impact generally protect water from the point of diversion associated with the right transferred or leased to instream use, through the Little Deschutes River mainstem and down to the mouth of the river. Some projects also protect water past the mouth of the Little Deschutes River and into the mainstem Deschutes River.

In the first five years of the Mitigation Program, the Department reported that none of the mitigation established in the Little Deschutes had been used to provide mitigation for new uses within this zone. Rather, it was used in other zones, the Upper Deschutes Zone specifically. At the time, there had only been one new groundwater permit within this zone, which was a non-consumptive use (commercial heat exchange) with a mitigation obligation of zero acre feet.

There are now three permits in the Little Deschutes Zone of Impact. The two newer permits are for irrigation and storage with pond maintenance. The full mitigation obligation for all three permits is 13.2 AF. There are no municipal or quasi-municipal groundwater permits in this zone of impact. Through 2012, all mitigation for permits within the Little Deschutes Zone of Impact was supplied by instream leases (temporary mitigation). However, there have been several permanent mitigation projects that have resulted in available mitigation within this zone.

In 2012, there were three instream leases used to establish temporary mitigation. Credits from these projects were available for use as mitigation also within downstream zones of impact, being the Upper Deschutes, Middle Deschutes, and General Zones of Impact. Water from these projects was protected instream in the Little Deschutes River and into the mainstem Deschutes River. Credits from these projects were used to provide mitigation to groundwater permits in the Little Deschutes and the downstream zones of impact.

By end of 2012, there were 5 permanent mitigation projects in this zone. Two of these projects are for a specific groundwater permit application and for use only in the Little Deschutes Zone of Impact. The other projects made mitigation available for other pending applications and existing groundwater permits. However, one of the other three permanent projects only made mitigation available in the Little Deschutes Zone of Impact. Figure 25 shows the increase in the amount of mitigation available over for the last five years.

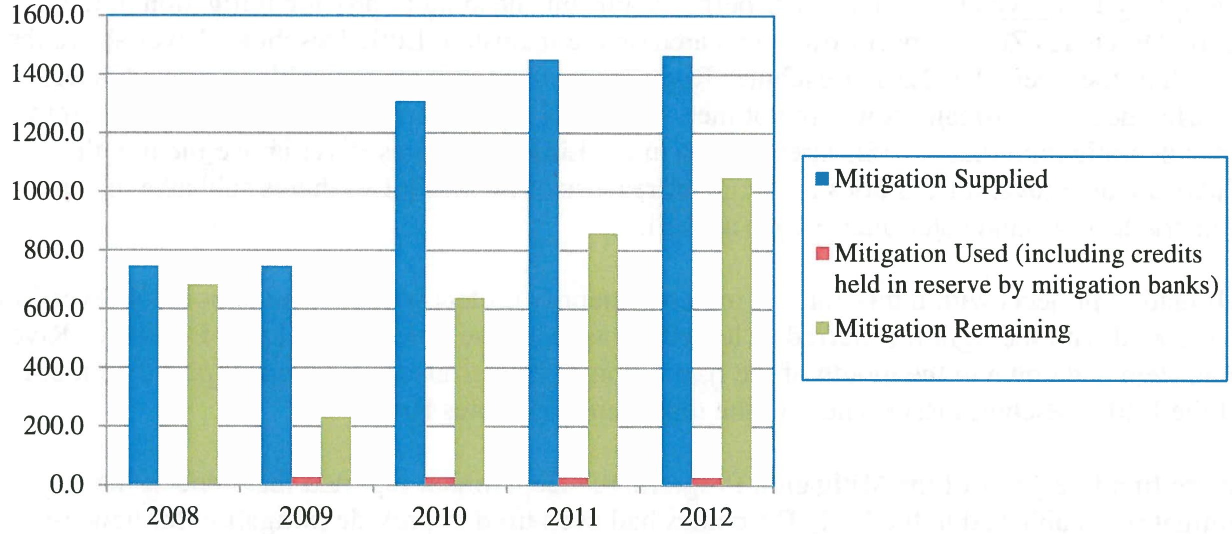


Figure 25. Total mitigation supplied and used in the Little Deschutes Zone of Impact.

Very little mitigation has been used in the Little Deschutes Zone of Impact. Most of the mitigation established in this zone is used in the Upper Deschutes and General Zones of Impact.

There are 8 groundwater permit applications pending that will impact streamflows in the Little Deschutes Zone of Impact. If approved, these applications will need mitigation established in this zone. One of the pending applications (quasi-municipal use) already has partial mitigation from two of the projects that established mitigation only in the Little Deschutes Zone of Impact.

Another three of the pending applications are also for quasi-municipal water use and have been identified by OWRD as impacting flows in Crescent Creek, which is tributary to the Little Deschutes River. OWRD has further identified that mitigation provided in the Little Deschutes Zone of Impact will not mitigate for impacts to Crescent Creek, including instream rights and other surface water rights, unless mitigation is provided in Crescent Creek. There is no zone of impact in the Crescent Creek subbasin. OWRD and ODFW staff are working with the applicant to identify whether suitable mitigation may be provided that will mitigate for impacts to Crescent Creek and to the Little Deschutes Zone of Impact.

The remaining applications are irrigation and storage with pond maintenance. The full mitigation obligation for all pending applications is 1383.2 AF based on their individual proposals. However, the quasi- municipal applicants may opt to provide mitigation incrementally, which would reduce the initial amount of mitigation required for impacts to streamflows. As of 2012, there was 1465.5 AF of mitigation established in the Little Deschutes of Impact. Of that, only 26.4 AF (including reserves) has been used to mitigate for impacts within the Little Deschutes Zone of Impact.

In the mainstem Little Deschutes River, approximately 14.53 cfs and 3054.8 AF were protected instream in 2012 under instream leases and instream transfers used to establish mitigation. As identified above, the impact of the rights permitted under the Mitigation Program is 13.2 AF with only 26.4 AF of mitigation being used (including reserves). More water has consistently been protected instream in the Little Deschutes River through the zone of impact than used to mitigate for streamflow impacts. Some of the mitigation water was used in downstream zones of impact but, as shown in Figure 25, a large portion of the mitigation water has remained unused and is available to meet future needs by the pending applications and potential new applications.

Upper Deschutes: Groundwater permit applicants identified by OWRD as needing to provide mitigation in the Upper Deschutes Zone are impacting flows in an area on the mainstem Deschutes River above River Mile 185. Scenic Waterway and instream water right flows are not met in the upper portion of the Deschutes River. Much of the upper Deschutes River is also vulnerable to interference from groundwater use. River Mile 185 is located just below where groundwater discontinues discharging to surface water and new uses in the area do not appear to interfere with surface water flows downstream from River Mile 185. Therefore, groundwater permit applicants are required to provide mitigation that benefits streamflows in the Upper Deschutes River above River Mile 185.

No mitigation projects have been proposed to establish mitigation beginning in the Upper Deschutes Zone of Impact. Rather all mitigation projects, which have provided mitigation within this zone, originated in the Little Deschutes Zone of Impact. As of 2012, there was 4.46 cfs and 1201.6 AF protected instream through the lower most end of this zone between the mouth of the Little Deschutes and River Mile 185. Protected water also extended through the Deschutes River and down to Lake Billy Chinook, at approximately River Mile 120. A portion of this water, as described below and shown in Figure 26, was used for mitigation purposes. Mitigation projects established 675.9 AF of mitigation in this zone in contrast to the full amount of water protected instream.

Mitigation credits for the Upper Deschutes Zone of Impact first became available in 2006 and were based upon instream leases. Since 2006, mitigation based on permanent instream transfers has also become available for the Upper Deschutes Zone of Impact. By 2012, there were 4 mitigation projects from which mitigation was available for use in the Upper Deschutes Zone of Impact, two instream leases and two permanent instream transfers. All four of which originated in the Little Deschutes Zone of Impact. However, mitigation water (protected instream flows) from these projects provided instream benefits to flows in a portion of the impacted stream reach of the Upper Deschutes Zone of Impact.

The amount of mitigation available from 2008 through 2012 has been consistent. As of year-end 2012, there were 5 permits with a mitigation obligation in the Upper Deschutes Zone of Impact with a total mitigation obligation of 46.1 AF. Three of the permits are, at least in part, providing mitigation under permanent instream transfers. The remaining mitigation balance is met with mitigation from instream leases. The other two permits, prior to 2011 had been providing mitigation also from instream leases. However, both of these permits did not satisfy their mitigation obligations in 2012 by purchasing credits from the DRC Mitigation Bank. Regardless, based upon available supply of mitigation, there has been sufficient mitigation available within this zone of impact (Figure 26).

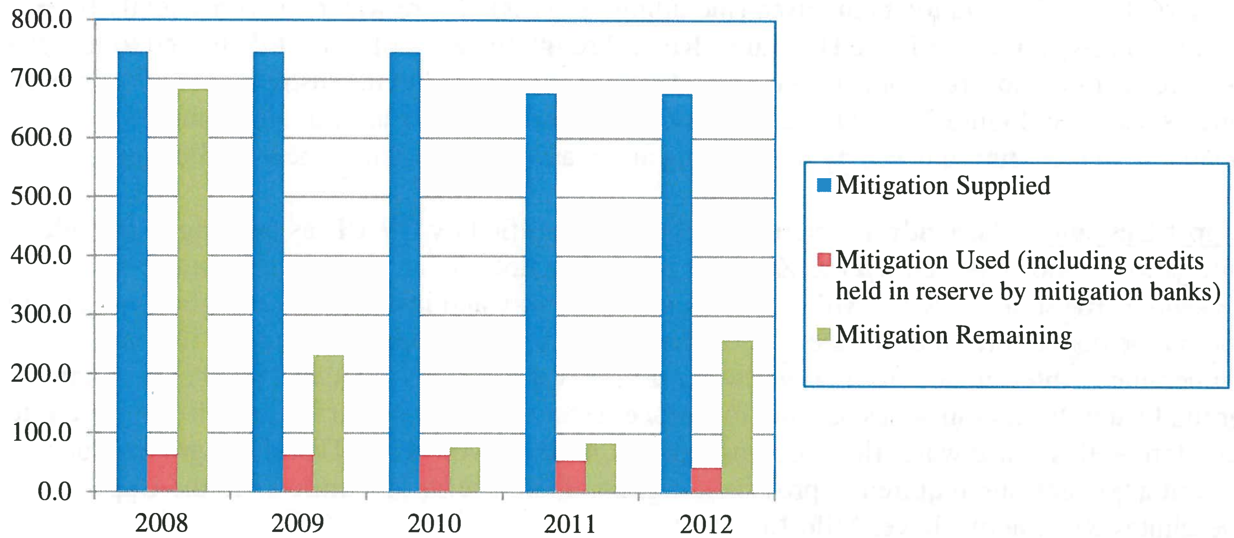


Figure 26. Total mitigation supplied and used in the Upper Deschutes Zone of Impact.

There is only one application pending within this zone of impact. This is a quasi-municipal water use and will likely provide mitigation under an incremental development plan. Based upon information available, this application, if issued a permit, will only need an initial 2.1 AF of mitigation. As of year-end 2012, there appears to be sufficient mitigation available to meet the need of this pending application and potential future demands for mitigation in this zone of impact. However, as shown in Figure 26, the remaining supply of mitigation for this zone fluctuates from year to year and is affected by mitigation demands in the Little Deschutes Zone of Impact and other downstream zones.

Metolius River: Instream flow needs are generally met in the Metolius River subbasin. However, the mainstem river and many of its tributaries above Jefferson Creek are vulnerable to interference by groundwater use. Therefore, mitigation by groundwater permit applicants identified as impacting flows within the Metolius River Zone of Impact must provide mitigation above River Mile 28, which is the approximate location of the confluence of Jefferson Creek with the Metolius River.

Within the first five years of the mitigation program, there were no groundwater applications determined to have a mitigation obligation within this zone. In 2008, OWRD identified the first groundwater permit application with an impact on flows within the Metolius River Zone of Impact. However, no mitigation projects have been proposed that would establish mitigation water within the Metolius River Zone of Impact. The pending permit application has been issued a Final Order and has five years from the date the Final Order was issued to provide the required mitigation. The Final Order expires just before the end of the 2013 calendar year.

Scenic Waterway & Instream Water Right Flow Evaluation

On a five year cycle, the WRC is required to evaluate mitigation activity in the Deschutes Basin to determine whether scenic waterway flows and instream water right flows continue to be met on at least an equivalent or more frequent basis as compared to long-term, representative base period flows established by the Department. This is the second five-year evaluation of the mitigation program and covers 2008 through 2012.

Instream Flow Model

To monitor the impact of new groundwater permits and mitigation on scenic waterway flows and instream water right flows, the Department developed a streamflow monitoring model using historic streamflow data (Cooper, 2008). The streamflow model was constructed using a base period of flows from 1966 to 1995 at selected gaging stations around the basin. This base period represents river flows during a period of time after all of the dams were constructed and before the Scenic Waterway Act was amended to include consideration of groundwater impacts.

The model considers the effects of new permitted groundwater use and mitigation projects on streamflows.[2] In addition to mitigation projects, which protect water instream, there are also ongoing streamflow restoration projects throughout the Deschutes Basin. Given that the purpose of this streamflow model is to track the effects of new permitted groundwater use and mitigation projects on streamflows, other restoration projects are not included in this model.

Table 2 shows the modeled annual results through 2012 for all evaluation sites used in the model. Monthly results from the model are included in Appendix B.

Table 2. Modeled results showing baseline and changes in the percent of time instream requirements are met.

Gage Site	Base Line % Time Instream Requirements are met	Change in Percent of Time Instream Requirements are Met	Annual change in streamflow (cfs)
Deschutes River at Mouth	96.2	-0.03	-3.24
Deschutes River below Pelton Dam	69.3	+0.21	-3.24
Deschutes River at Lake Billy Chinook	99.3	+0.42	+7.45
Deschutes River at Lower Bridge (downstream of Bend)	28.6	-0.15	+11.5
Deschutes River Upstream of Bend	67.4	+0.13	+7.02
Deschutes River at Benham Falls	63.7	-0.12	+0.82
Deschutes River above Little Deschutes River	63.5	0.0	0.0

[2] R.M. Cooper, Assessing the Impact of Mitigation on Stream Flow in the Deschutes Basin (Appendix A)

Gage Site	Base Line % Time Instream Requirements are met	Change in Percent of Time Instream Requirements are Met	Annual change in streamflow (cfs)
Little Deschutes River at mouth	45.3	-0.05	+0.87
Metolius River at Lake Billy Chinook	99.7	0.0	0.0

Instream flows for the Deschutes River below Bend showed a slight decrease in the percent of time the instream flows are met. However, streamflows overall were increased by 11.5 cfs. The mitigation effects on streamflow for the reach below Bend demonstrate some of the nuances of the mitigation program, specifically how stream flows can be met less on a *percentage basis* after mitigation when there is an overall *increase in stream flow* (i.e., *volume* of water increased).

This phenomenon was explained in the previous five-year report and is repeated here for reference purposes. To understand why this seemingly conflicting result occurs, two facts related to the mitigation program need to be explained. First, mitigation debits (i.e., new groundwater withdrawals) produce a decrease in streamflow that is uniformly distributed over the year (Cooper 2008), while mitigation credits (e.g., instream transfers and leases) generally increase stream flow seasonally—during the irrigation season. Second, the instream requirements for the river below Bend are very close to historical flows during the winter, but the summer instream requirements far exceed historical flows (Figure 27).

Since mitigation produces a slight decrease in flow (~1.4 or -0.21 percent) during winter (red line, Figure 27), and because the instream requirements are close to the historical flows, the decrease in flow also decreases the percent of time the mitigated flows meet the instream requirements.

Conversely, during summer, the instream requirements far exceed historical summer flows. Therefore, even though there is an increase in summer flows due to mitigation, the increase is of insufficient magnitude to increase the percent of time the instream requirements are met (Figure 27). The overall result is that the instream requirements are met less often during winter due to a decrease in flow, while the increase in flow during summer does not change the percent of time the instream requirements are met. This result occurs even though there is an overall increase in the annual flow below Bend.

In the Whychus Zone of Impact, the Department installed an additional gage at Camp Polk Road in May 2007 to monitor groundwater inputs through springs. This gage is specifically designed to monitor localized impacts to the groundwater system near Sisters and surrounding areas by local well pumping. In addition, the Department added a gage on the Metolius River just downstream of Camp Sherman to monitor similar effects. Lastly, the USGS and the US Department of Interior's Bureau of Land Management installed a gage on the Crooked River near Osborne Canyon some years ago to monitor groundwater fluxes in that reach of river.

Real-time Streamflow Records

The Department primarily uses a database and streamflow model to monitor the effectiveness of the mitigation program. However, over time, yearly real-time streamflow records can also be tracked at appropriate gaging stations or other measurement locations. In the short term, streamflow data will not provide information on how the system is responding, given changes in climatic conditions and other variables. It is not possible to correct real-time data for effects of year-to-year changes in weather (or other variables) with sufficient accuracy. In addition, it may be years before the effects of mitigation activities and groundwater use reach equilibrium though trends may become apparent over a longer period of time.

Because of the variability of the system, streamflow records will not be able to detect changes due to mitigation activity. One exception is the Deschutes River below Bend where the combination of mitigation, conservation, and flow restoration, sets the target for minimum flows below the large irrigation districts every year. At this location, streamflow is always over the historical 30 year median of 35 cfs. Figure 27.

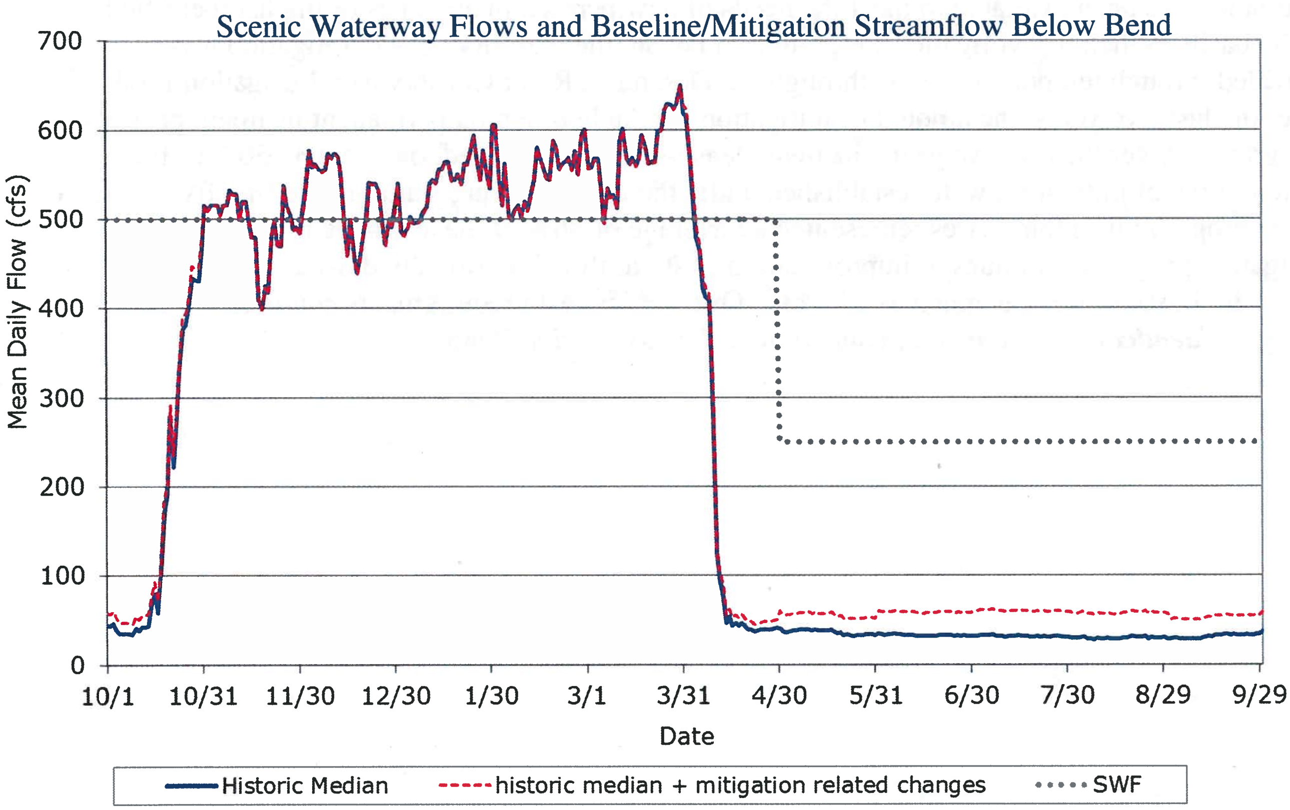


Figure 27. Changes to baseline streamflow conditions on the Deschutes River below Bend due to Mitigation Program compared to Scenic Water Way Flows.

Over the past year, the Department has been in the process of further developing a database in which to track new groundwater uses approved under the Mitigation Program and related mitigation by zones of impact. The Department hopes to be able to provide links between this database and the streamflow model to continue to improve how it tracks the effectiveness of the mitigation program.

In addition, when the first five year evaluation of the mitigation program was complete, a report describing the streamflow model (Cooper, 2008) was still in draft stage and undergoing peer review. Since that first evaluation of the Mitigation Program, this report has been completed and is attached as Appendix A. The finalized report was published in November 2008.

Summary

The Deschutes Groundwater Mitigation Program has been in place since 2002. To date, 95 permits have been issued in the groundwater study area primarily for irrigation, industrial, quasi-municipal and municipal uses. Permits and final orders awaiting mitigation total over 141 cfs of groundwater. Pending groundwater applications do not exceed the quantity available under the 200 cfs cap.

Mitigation has been available to meet the needs of new permits in all zones of impact identified in the basin. When the Mitigation Program first began, the majority of that mitigation was provided through temporary credits through the Deschutes River Conservancy Mitigation Bank. Over the last five years, the amount of mitigation available based on permanent instream projects has grown. Over the last five years, instream leases have represented, on average, 50% of the total volume of mitigation water established under the mitigation program. In the first five years of the program, instream leases represented an average of 86% of the available mitigation. The mitigation program continues to improve summer streamflow in critically dewatered reaches in the basin, in some areas as much as 26.2 cfs. Overall, instream requirements *continue to be met at nearly identical levels annually compared to the base period flows.*

Deschutes Ground Water Mitigation Program

Five-Year Program Evaluation Report

February 29, 2008

State of Oregon
Water Resources Department

5-Year Evaluation of the Deschutes Ground Water Mitigation Program

Contents

Introduction 1
The Basin 2
Deschutes Ground Water Study 2
Mitigation Program Development 4
Mitigation Program Goals 5
Elements of Mitigation Program 5
Establishing New Ground Water Uses 6
Status of the 200 cfs Allocation Cap 7
Establishing Mitigation Water and Credits 10
Mitigation Banks 12
Effectiveness of Mitigation Projects 14
Zone of Impact Evaluation 19
Scenic Waterway & Instream Water Right Flow Evaluation 28
Summary 32

Special thanks to Kyle Gorman, WRD,
for photographs used in this report

Introduction

The Deschutes Ground Water Mitigation Program was developed to provide for new ground water uses while maintaining scenic waterway and instream water right flows in the Deschutes Basin. The program is authorized under ORS 537.746 and House Bill 3494 (2005 Oregon Law) and implemented in Oregon Administrative Rules (OAR) Chapter 690, Divisions 505 and 521.

Much of the mainstem Deschutes River and its tributaries are protected by scenic waterway designations and instream water rights. There are also existing surface water rights on the Deschutes River and its tributaries for out of stream uses, such as irrigation and municipal. In the Deschutes Basin above Lake Billy Chinook there is a hydraulic connection between ground water and surface water flows. Because of this connection, ground water withdrawals affect surface water flows. Since scenic waterway flows and instream water rights are not always satisfied, the Department may not approve new ground water permits unless the impacts are mitigated. The mitigation program provides a set of tools that applicants for new ground water permits can use to establish mitigation and, thereby, obtain new permits from the Department.

Every five years the Water Resources Commission (WRC) is required to evaluate the effectiveness of the mitigation program. The purpose of this evaluation is to ensure that scenic waterway and instream water right flows continue to be met on at least an equivalent or more frequent basis compared to flows within a representative base period. Depending upon the outcome of this evaluation, the Commission may modify the program accordingly. This may include adjusting the allocation cap on new ground water uses that was established under the program. The Commission may also initiate proceedings to declare all or part of the basin a critical ground water area, close all or part of the basin to additional ground water use, or take other administrative action. This report provides the background and evaluation material to help inform the Commission as it reviews the program.

Mitigation Review Criteria

- *Whether scenic waterway and instream water right flows continue to be met on at least an equivalent or more frequent basis as compared to long-term, representative base period flows established by the Department;*
- *Evaluation of the mitigation program, associated mitigation, the zones of impact; and*
- *Evaluation of the effectiveness of mitigation projects and mitigation credits that involve time-limited instream transfers, instream leases and allocations of conserved water from canal lining and piping projects.*

The Basin

The Deschutes River Basin covers about 10,700 square miles in central Oregon, making it the second largest watershed in the state and one of the major subbasins of the Columbia River system. The basin is bounded on the west by the Cascade Mountains, on the south by lava plateaus, to the east by the Ochoco Mountains and the plateau between the Deschutes and John Day Rivers, and to the north by the Columbia River. The basin measures 170 miles in the north-south direction and ranges up to 125 miles at its greatest width.

The major tributaries feeding the Deschutes River include the Little Deschutes River, Tumalo Creek, Fall River, Shitike Creek, the Crooked River, the Metolius River, Whychus Creek, Trout Creek, the White River, and the Warm Springs River (Figure 1).

Deschutes Ground Water Study

The U.S. Geological Survey (USGS) initiated a ground water study in 1993 to provide much needed information on the ground water resources of the upper Deschutes Basin. The study was conducted in cooperation with the Water Resources Department (WRD); the cities of Bend, Redmond and Sisters; Deschutes and Jefferson counties; the Confederated Tribes of the Warm Springs Reservation of Oregon; the U.S. Environmental Protection Agency and the Bureau of Reclamation. The area of the study is shown in Figure 1.

Conclusions from the study demonstrated that nearly all ground water originating in, or flowing through, the upper Deschutes Basin discharges into relatively short reaches of the Deschutes, Metolius and Crooked Rivers above and within Lake Billy Chinook.

The study concluded that:

- Virtually all ground water not consumptively used in the upper Deschutes Basin discharges to surface water near Pelton Dam;
- Virtually the entire flow of the Deschutes River at Madras is supported by ground water discharge during the summer and fall; and
- Ground water and surface water are directly linked, and removal of ground water will ultimately diminish streamflow.

Based on initial study conclusions available in 1998, Department determined ground water use in the Deschutes Ground Water Study Area (DGWSA) had the potential for substantial interference with surface water and the measurably reduce" standard in the Scenic Waterway Act (ORS 390.835) was triggered.

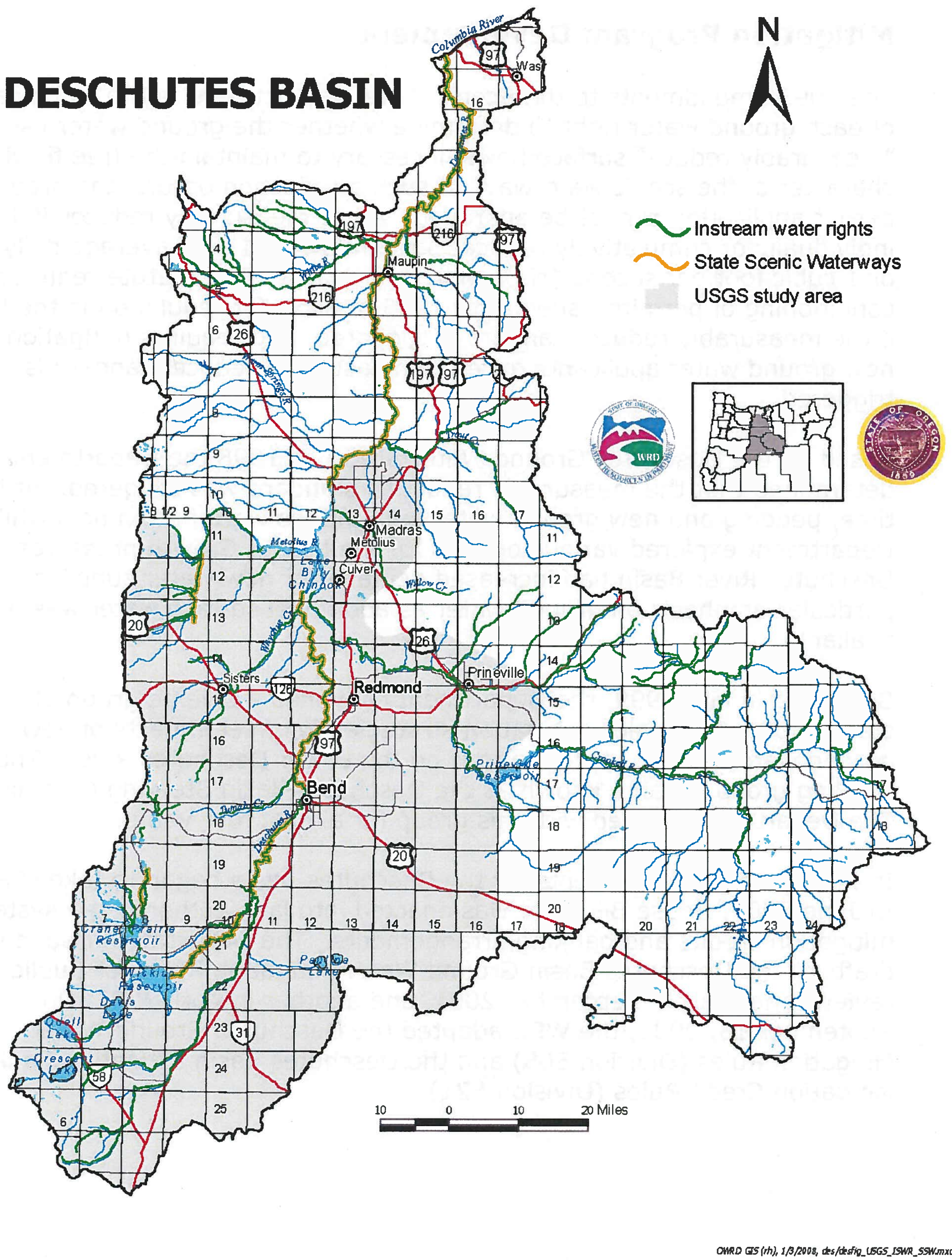


Figure 1. Deschutes River Basin and ground water study area.

Mitigation Program Development

The 1995 amendments to the Scenic Waterway Act require the examination of each ground water right to determine whether the ground water use will "measurably reduce" surface flows necessary to maintain the free flowing character of the scenic waterway. If such a reduction occurs, the proposed permit application cannot be approved. A use measurably reduces if it individually or cumulatively reduces streamflow by 1% of average daily flow or 1 cubic foot per second (cfs), whichever is less. The statute requires conditioning of permits issued after 1995 to allow for regulation in the future if the measurably reduce standard is triggered, and requires mitigation by new ground water applicants once the measurably reduce standard is triggered.

Based on the Deschutes Ground Water Study, in 1998 the Department determined that the measurable reduction standard was triggered. At that time, pending and new ground water applications were put on hold while the Department explored various options for the basin. Growth pressures in the Deschutes River Basin had increased demand for new water supplies, with a particular emphasis on ground water as additional surface water was not available.

Beginning in late 1999, the Department convened a diverse group of stakeholders to develop mitigation strategies to offset impacts of new ground water permit appropriations on the Lower Deschutes River. This working group became known as the Deschutes Basin Steering Committee. The Department worked with this group for almost four years.

In 2001, mitigation concepts for the Deschutes Basin began to take shape. In June 2001, House Bill 2184 was enacted into law, authorizing a system of mitigation credits and banking arrangements. The Department issued two drafts of the Deschutes Basin Ground Water Mitigation Rules for public review, one draft in September 2001, and another in April 2002. On September 13, 2002, the WRC adopted the Deschutes Ground Water Mitigation Rules (Division 505) and the Deschutes Basin Mitigation Bank and Mitigation Credit Rules (Division 521).

Mitigation Program Goals

The goals of the Deschutes Mitigation Program are to:

- Maintain flows for Scenic Waterways and senior water rights, including instream water rights;
- Facilitate restoration of flows in the middle reach of the Deschutes River and related tributaries; and
- Sustain existing water uses and accommodate growth through new ground water development.

Elements of Mitigation Program

The mitigation program has five basic elements:

- Requires mitigation for all new ground water permits in the DGWSA;
- Identifies tools for providing mitigation through either a mitigation project or by obtaining mitigation credits;
- Establishes a system of mitigation credits, which may be used to offset the impacts of new ground water permits,
- Provides the process to establish mitigation banks; and
- Provides for adaptive management through annual evaluations and review of the mitigation program every five years.

Deschutes River below mouth of Tumalo Creek

Establishing New Ground Water Uses

The process for establishing a new ground water use in the Deschutes Basin is depicted in Figure 2. For each ground water application submitted, the Department reviews the application and notifies the applicant of their "mitigation obligation." The "mitigation obligation" is expressed as a volume of water in acre-feet and is equivalent to the consumptive portion of the use proposed in the permit application. Groundwater applicants mitigate for this consumptive portion of their proposed use. Consumptive use is calculated using average consumptive use data for different types of use (i.e. irrigation, municipal, etc.) obtained from the U.S. Geological Survey and Department's own information on consumptive use. In certain cases, there may be information available in the application record that suggests that the consumptive use portion should be calculated differently. The Department takes that information into consideration with evaluating the application.

Mitigation must be provided in the amount (mitigation water) and in the location (zone of impact) specified by the Department. Zones of impact are based upon where the proposed use will primarily impact surface water flows. Each applicant has five years from the date the final order is issued to provide the required mitigation. Applicants must provide mitigation before a new permit may be issued.

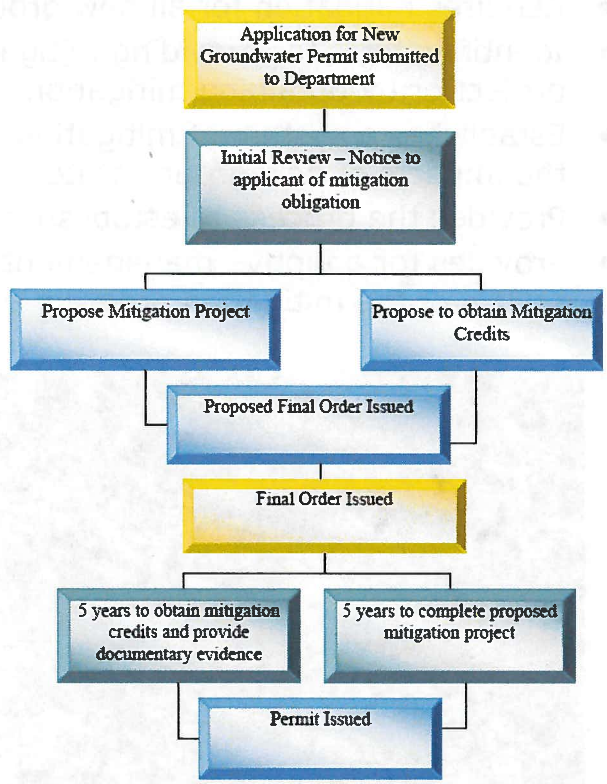


Figure 2. Process to establish new ground water uses under the Deschutes ground water mitigation program.

Status of the 200 cfs Allocation Cap

The Deschutes Ground Water Mitigation Program is a performance based, adaptive approach to managing new ground water permits in the Deschutes Ground Water Study Area. As part of this adaptive approach, the program included a cap on how much new ground water use can be approved. Department may issue final orders approving ground water permit applications for a cumulative total of up to 200 cfs. This limitation is one of the elements of the program that is to be reviewed as part of the evaluation of the program. The 200 cfs cap represents the rate up to which water may be withdrawn from the ground water resource. It is important to note that this rate-based limitation is different from the consumptive use portion (in acre-feet) for which ground water permit applicants must provide mitigation.

Since adoption of the rules in September 2002, 66 new ground water permits with associated mitigation have been issued, totaling 52 cfs of water (Figure 3). An average of 13 new ground water permits have been issued annually since the program began.

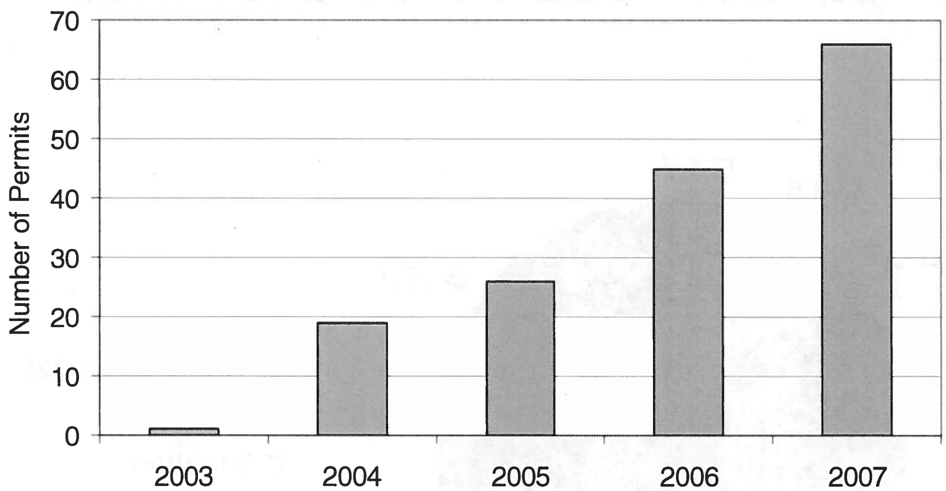


Figure 3. Cumulative total permits issued by year.

Permits for those applications that have been issued final orders[1] with proposed approvals can be issued if the required mitigation is received by the Department. Each applicant has five years from the date the final order is issued to provide the required mitigation. The final order approving the use expires if mitigation is not provided within the five year period. Of the final orders issued without permits, 10 of those (totaling approximately 18.0 CFS) have five year deadlines to provide mitigation that end in 2009.

---

[1] A final order is the last stage of the permitting process prior to issuance of the permit.

As shown in Figure 4, the cumulative amount of water approved in new permits and in permit applications with final orders is 85 cfs. This is roughly 42% of the total amount allowed under the allocation cap. A summary by type of use is provided in Figure 5.

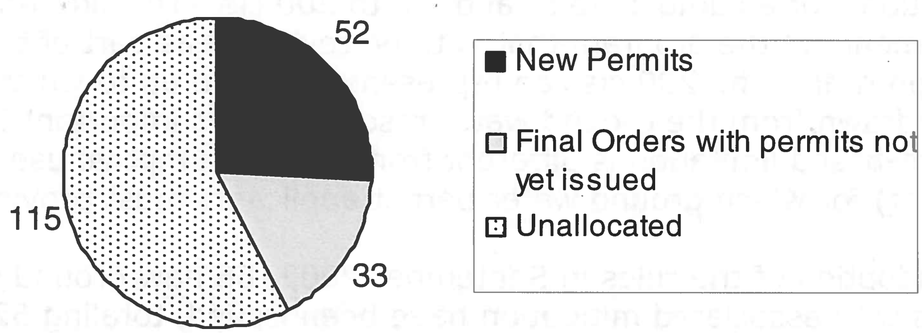


Figure 4. Amount of water in cfs of the 200 cfs allocation cap that has been allocated under new permits and final orders and the amount unallocated.

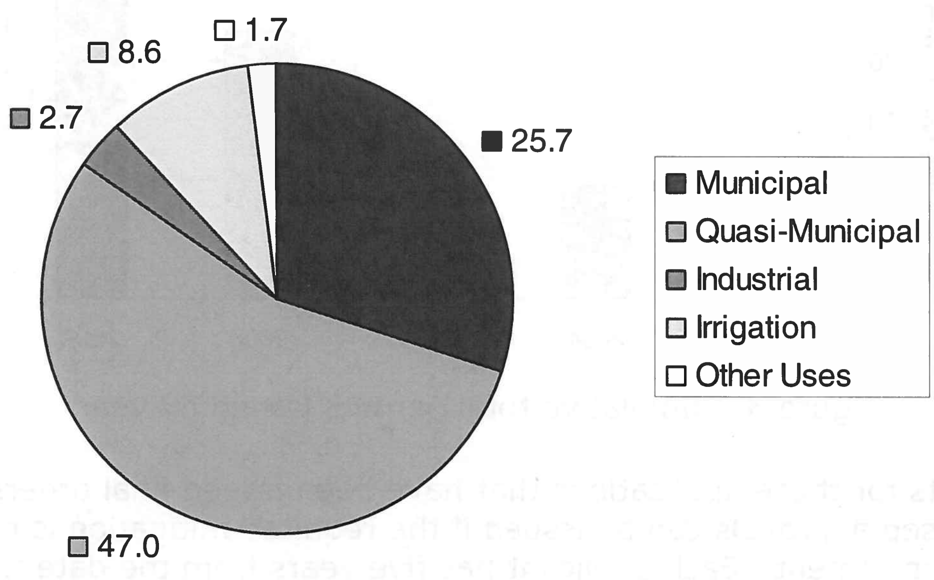


Figure 5. Amount of water in cfs of the 200 cfs allocation cap that has been allocated under new permits and final orders by type of use.

There are currently 40 applications pending without final orders that total approximately 144 cfs (see Figure 6). Ten of these pending applications fall outside of the 200 cfs cap and are not being processed by the Department, even in cases where the use is non-consumptive and has no mitigation obligation. As applications move up in the application "cue", the amount requested is sometimes modified to reduce the requested rate or the application is withdrawn or denied. As this occurs, other applications can be processed within the 200 cfs cap. For example, since adoption of the rules, 26 applications (totaling approximately 24 cfs) have been withdrawn and five applications (totaling approximately 2 cfs) have been denied. These five applications were denied when the applicants failed to respond to the Department's request for mitigation information.

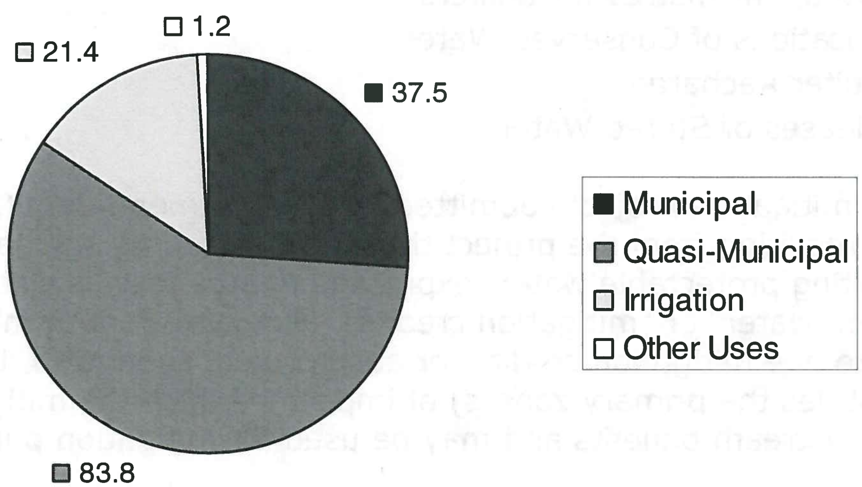


Figure 6. Amount of water in cfs of pending groundwater applications without final orders by type of use.

Allocation Summary

- *66 new ground water permits issued*
- *42% of cap allocated under final orders and new ground water permits*
- *Pending applications exceed remaining balance of the 200 cfs cap*

Establishing Mitigation Water and Credits

The Deschutes Basin Ground Water Mitigation Rules provide ground water permit applicants two options to satisfy the requirement to mitigate: 1) completion of their own mitigation project or 2) acquisition of mitigation credits.

The rules identify several types of projects that can be used to establish mitigation water:

- Instream Leases[2]
- Time-Limited Instream Transfers
- Permanent Instream transfers
- Allocations of Conserved Water
- Aquifer Recharge
- Releases of Stored Water

For each mitigation project submitted, the Department identifies the amount of water resulting from the project that can be used for mitigation purposes. The resulting protectable water, expressed in acre feet, is also referred to as "mitigation water" or "mitigation credits". One acre-foot of mitigation water is equal to one mitigation credit. For each project submitted, the Department also identifies the primary zone(s) of impact in which the mitigation water provides instream benefits and may be used for mitigation purposes.

Mitigation credits are simply a means of accounting for mitigation water made available by completion of a mitigation project by an individual or organization. Mitigation credits, unless generated by instream leases or time-limited instream transfers, may be held by anyone. Credits can be conveyed from a "mitigation credit holder" to a ground water permit applicant and used to satisfy the mitigation obligation of the proposed use.

To use mitigation credits, ground water permit applicants show that they have obtained the needed mitigation credits by submitting a documentary evidence form (developed by the Department). This form must be completed by the mitigation credit holder and the permit applicant. The documentary evidence form is submitted to the Department for review. If the mitigation credits conveyed to the ground water applicant match the mitigation obligation, a new permit may be issued.

[2] Instream leases and time-limited instream transfers may only be used by mitigation banks to establish mitigation credits.

The Department maintains an accounting record of mitigation projects and mitigation credits with links to any associated ground water permits. Sources of mitigation include instream transfers and instream leases. As shown in Figure 7, in each year that the program has been in place, there has been sufficient mitigation to meet the needs of ground water permits issued under the program. This includes mitigation that is maintained as "reserve" credits by the mitigation banks.

Mitigation banks that use instream leases to generate mitigation credits are required to hold in reserve one matching credit for each credit they assign to a ground water permit. Leases are allowed for periods of one to five years and can be terminated early so the active number of leases fluctuates from year to year. The reserve mitigation credit provides some backup for ground water permit holders and additional assurance for streamflow protection.

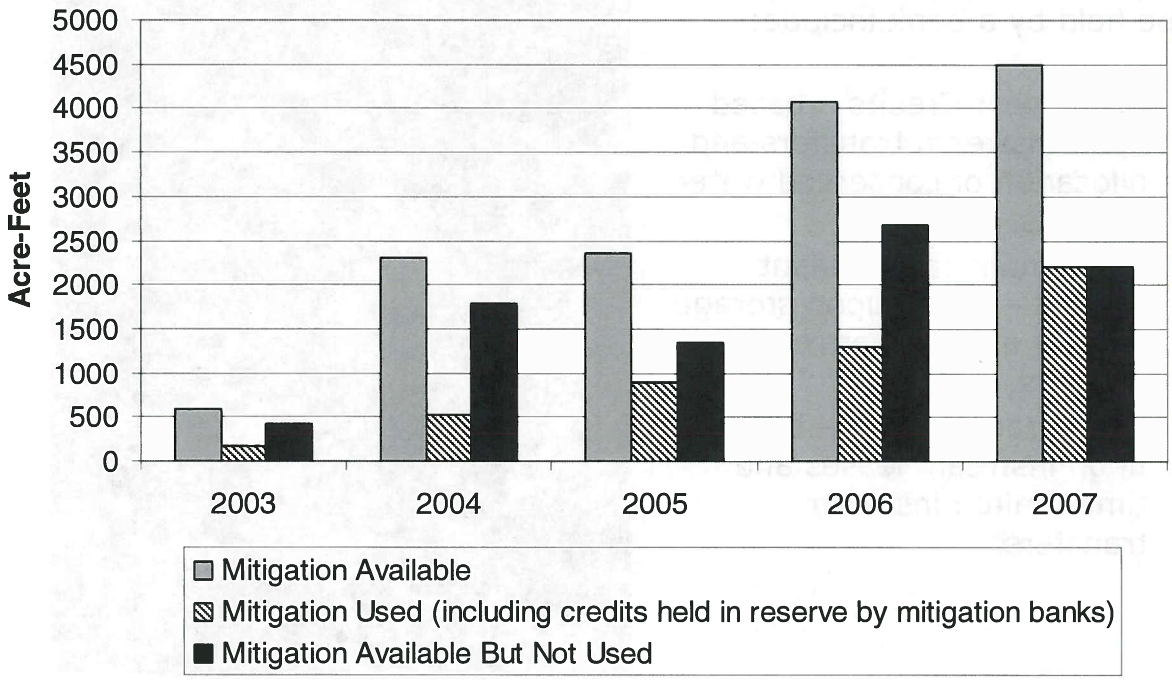
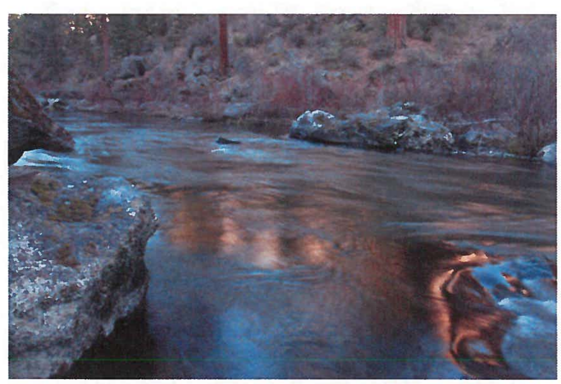


Figure 7. Total mitigation available compared to mitigation used by new ground water permits and used as bank "reserves." The amount of mitigation established but not used is also shown.

Mitigation Summary

Mitigation established each year has consistently exceeded the amount needed (including for reserves) on average by 66%.

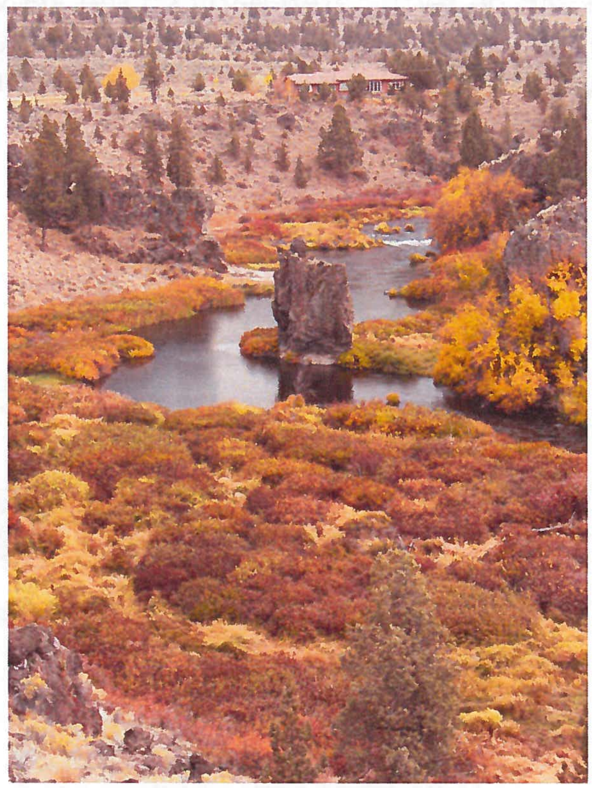


Mitigation Banks

The Deschutes Basin Mitigation Bank and Mitigation Credit Rules (Division 521) provide for the formation of mitigation banks for the Deschutes Basin. Anyone may apply to become a mitigation bank. Successful applicants must enter into an agreement, called a mitigation bank charter, with the Department. Each charter must be approved by the WRC. The charter describes the types of mitigation credits that may be held by the bank, how credit transactions should be conducted and reported to the Department, and requires the mitigation bank to submit an annual report to the Department.

The types of mitigation credits that can be held by a bank include:

- Permanent Credits – based upon instream transfers and allocation of conserved water projects.
- Performance Dependant Credits – based upon storage release and aquifer recharge projects.
- Temporary Credits – based upon instream leases and time-limited instream transfers.



Deschutes River at Lower Bridge

There are two mitigation banks in the Deschutes Ground Water Study Area.

<u>Deschutes Water Exchange Mitigation Bank</u>

The first mitigation bank to be established was the Deschutes Water Exchange (DWE) (affiliated with the Deschutes River Conservancy, DRC). The DWE Mitigation Bank was authorized under a charter agreement approved by the WRC in February 2003. The primary source of mitigation in the DGWSA has been mitigation credits held by the DWE Mitigation Bank. They brokered the first mitigation credit transaction under the mitigation program in 2003. The DWE has worked extensively with ground water applicants and permit holders to provide assistance, education and outreach on the mitigation program. They have partnered with irrigation districts and landowners in the basin to lease water rights to instream use and use those instream leases to generate mitigation credits. DWE is the sole mitigation bank in the basin that may broker in this type of temporary credits.

Demand and supply of mitigation credits from the DWE Mitigation Bank has increased progressively over the last five years in both quantity of mitigation credits and in the number of mitigation clients contracting with the bank to obtain mitigation credits (1 mitigation client in 2003 to 33 clients in 2007).

In 2007 the DWE Mitigation Bank began to hold permanent mitigation credits based upon an instream transfer. The 40 permanent mitigation credits were assigned to five groundwater permit holders that had been using temporary mitigation credits. These permit holders now have a permanent source of mitigation. These permanent credits were acquired and marketed in cooperation with the Deschutes Water Alliance (DWA). The DWA is a cooperative group working to equitably redistribute surface water coming off of developing lands. The DWA includes the DRC, Deschutes Basin Board of Control, the cities and counties among its stakeholders.

<u>Deschutes Irrigation Mitigation Bank</u>

The second mitigation bank, Deschutes Irrigation (DI) LLC is operated by John Short and deals only with permanent credits. The DI Mitigation Bank charter was approved by the WRC in May 2006. To date, DI has not completed any mitigation credit transactions as a bank. Deschutes Irrigation LLC, acting solely as a company, has established mitigation credits based upon instream transfers. DI LLC has completed many mitigation credit transactions with ground water permit applicants and permit holders to provide those ground water users with a permanent source of mitigation. To date, none of these transactions have been brought through the DI LLC Mitigation Bank.

Effectiveness of Mitigation Projects

Under the Deschutes Ground Water Mitigation Rules, the WRC is required to specifically evaluate the effectiveness of mitigation projects that involve instream leases, time-limited instream transfers, and allocations of conserved water.

As shown in Figure 8, mitigation projects have been dominated by instream leases and instream transfers, with instream leases representing on average 86% of the total volume of mitigation water (in acre-feet) established under the program each year.

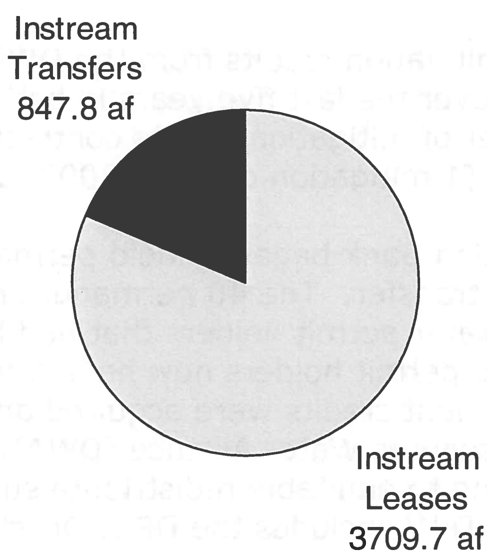


Figure 8. Distribution of mitigation water in acre feet (af) between instream leases and instream transfers in 2007.

Instream Leases

An instream lease is a temporary conversion (for up to five-years) of all or a portion of an existing water use to an instream water right. Since the mitigation program began, each year the amount of temporary mitigation credits generated by instream leases has far exceeded the amount needed to satisfy the mitigation obligations of those permits using these credits as their mitigation source and to meet "reserve" credit requirements (Figure 9). Temporary credits based on instream leases have also been sufficient in each zone of impact where these credits were used. Presently, only the DWE can use instream leases to establish temporary mitigation credits.

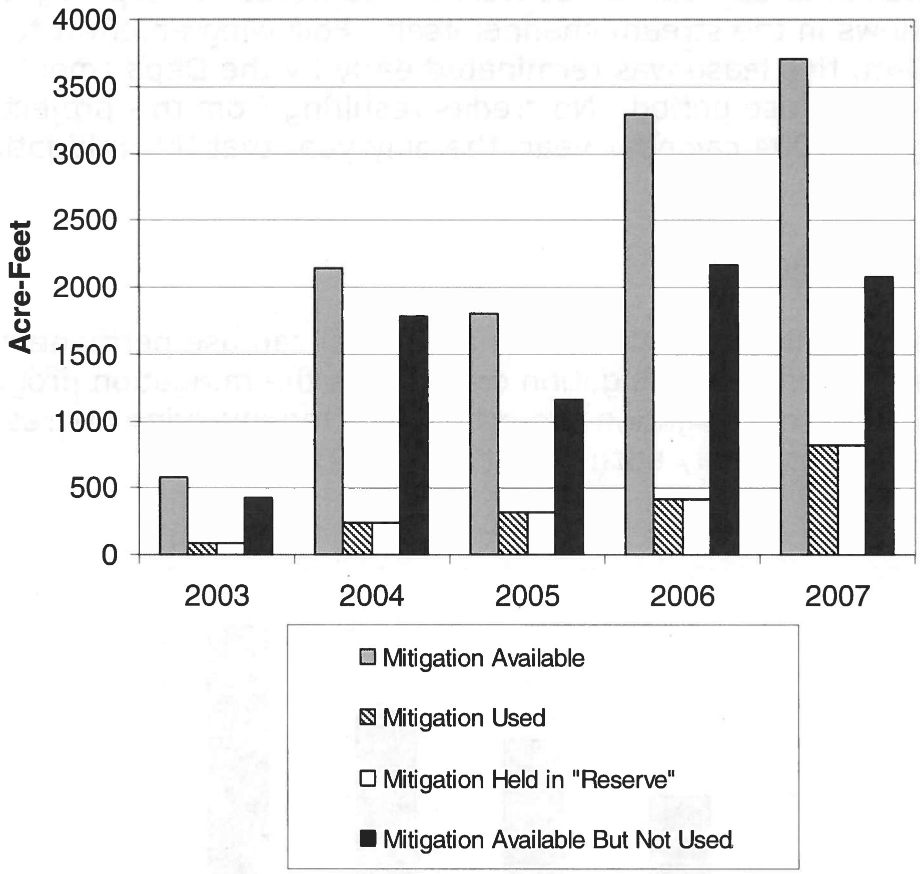


Figure 9. Mitigation created through instream leases.

While instream leases may fluctuate from year to year, overall, the annual volume of mitigation water provided through instream leases has increased over time (Figure 9). However, there was a reduction in 2005 in the quantity compared to the previous calendar year. This was likely due to the outcome of a legal challenge of the mitigation program that resulted in a brief suspension of the program at that time. Several instream leases that had initially been submitted as mitigation projects were modified to exclude mitigation and proceeded through the instream lease process solely as streamflow restoration projects. These modified instream lease applications did not result in any mitigation water (credits). The majority of instream leases used to establish mitigation credits have been for multiple year periods. However, leases used to establish mitigation in the Whychus Creek and Crooked River Zones of Impact have been for periods of one year.

In the five years of the program, only one issue has been encountered involving an instream lease used to generate mitigation credits. In 2004, several water rights were leased instream under a single lease on Paulina Creek, tributary to the Little Deschutes River. This instream lease resulted in mitigation credits within the Little Deschutes Zone of Impact. However, while this lease was in effect, difficulties were encountered in keeping the leased instream flows in the stream channel itself. Following an effort to correct this problem, this lease was terminated early by the Department, prior to the 2005 water use period. No credits resulting from this project were used during the 2004 calendar year, the only year that this mitigation project was active.

Permanent Instream Transfers

Any ground water permit applicant or other individual can use permanent instream transfers to generate mitigation credits. As the mitigation program has grown, the number of mitigation projects submitted involving instream transfers has increased steadily each year (Figure 10).

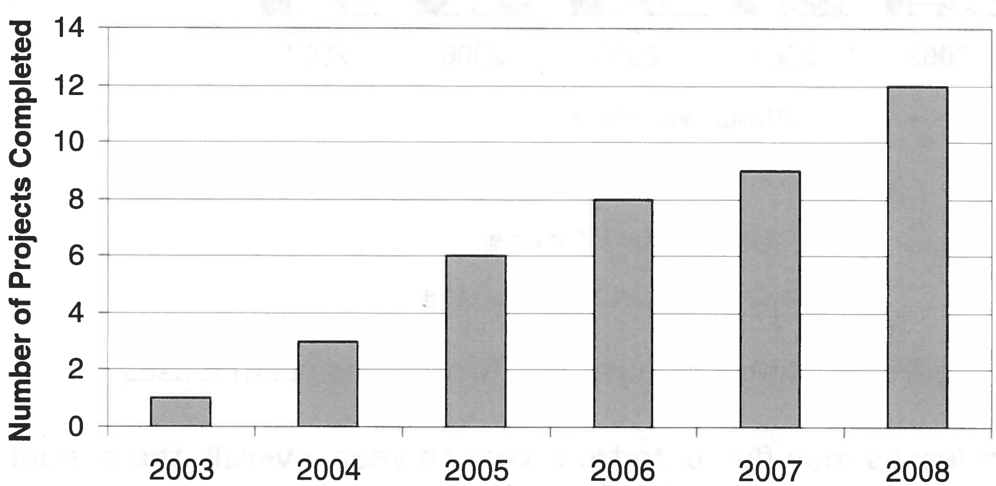


Figure 10. Cumulative number of mitigation projects involving permanent instream transfers.

Mitigation credits generated from projects based upon instream transfers are permanent in nature. Water is permanently protected instream as a result of the completion of an instream transfer application, resulting in a new instream water right. Use of these types of credits by a ground water permit holder does not require any ongoing maintenance of credits by the ground water user. Use of temporary mitigation credits (based on instream leases) requires annual ongoing maintenance of the credits.

In each year that the mitigation program has been in place, not all of the mitigation credits established by instream transfers have been used to provide mitigation to new ground water permits (Figure 11). Some of these mitigation credits have remained available. As more ground water permit applications are processed through to permit, more of these mitigation credits will be used.

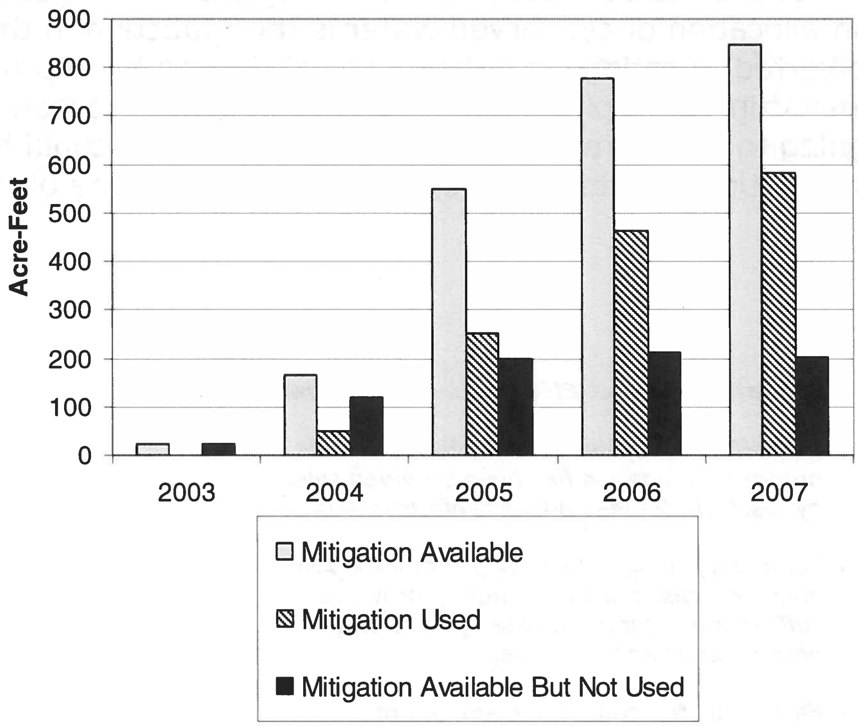


Figure 11. Mitigation created through permanent instream transfers.

Aquifer Recharge

One mitigation project has been proposed to the Department involving an aquifer recharge project. This project application has been protested, and the applicants are working with the Department to resolve the issues raised by the protest.

Other Mitigation Project Types

To date, no mitigation projects have been proposed to the Department involving time-limited instream transfers, allocations of conserved water, or release of stored water. Time-limited instream transfers differ from instream leases in that they can be issued for any length of time specified in the application. An allocation of conserved water is the reduction in the amount of water diverted to satisfy an existing beneficial use by improving the method of transporting or applying the water, with all or a portion of the conserved water going to instream use. Releases from storage could be used to generate mitigation credits based upon the annual volume of water released.

Mitigation Project Effectiveness Summary

- *In the first five years of the mitigation program, mitigation has been provided solely by instream leases and instream transfers.*
- *Temporary mitigation credits established from instream leases has consistently provided sufficient mitigation to meet ground water permit needs and reserves.*
- *Each year, the cumulative amount of permanent mitigation provided by instream transfers has increased.*

Zone of Impact Evaluation

As part of the five year evaluation, the WRC is required to evaluate the zones of impact identified by the Department. This evaluation may include analysis of where the zones are located, whether adequate zones are identified, and whether the mitigation program is doing an effective job of distributing mitigation water to the affected stream reaches within each zone of impact.

Ground water users with permits issued under the mitigation program are required to provide mitigation in a zone of impact identified by the Department. The purpose of these zones of impact is to target mitigation in and above stream reaches, on a subbasin level, where impacts on streamflows by ground water pumping are expected to occur.

Mitigation projects establish mitigation water within at least one zone of impact and may establish mitigation in more than one zone. Such a project would result in water that would benefit flows in each zone of impact identified. If credits are used in one zone they are also subtracted from use in the other zones in which they were available.

There is a general zone of impact to address regional impacts to surface water and local zones of impact for localized impacts. The general zone of impact is defined as anywhere in the Deschutes Basin above the Madras gage, located on the Lower Deschutes River, below Lake Billy Chinook. Ground water users with a general impact on surface water (i.e. impacting the regional confluence area of the Deschutes, Crooked and Metolius Rivers) may provide mitigation anywhere within the general zone of impact provided that the mitigation water (protected instream) flows into the impacted reach.

Mitigation within a local zone of impact is required for ground water uses that impact surface water on a localized level (e.g. impacting the surface waters of Whychus Creek). To define boundaries for the local zones of impact, the Department considered subbasin boundaries, locations where instream water rights or scenic waterway flows were not being met, general ground water flow information, and other hydrogeologic information, including identification of where stream reaches were influenced by groundwater discharge. By defining the boundaries for each of the local zones of impact, mitigation may be targeted in areas where mitigation projects may provide the greatest instream benefits.

To pinpoint the location of the lower boundary within each local zone, the Department used one of the following criteria:

1. For some local zones of impact, the lower boundary of the zone was defined as the point located below the lowest ground water discharge area. This allows the Department to target mitigation in and above areas of a stream basin where flows are influenced by groundwater discharge.

2. For other local zones of impact, the lower boundary of the zone was the point within the lowest ground water discharge area where instream requirements are not met above that point. Existing streamflow data was used to identify the approximate point at which instream flow needs begin to be met as water flows downstream through the affected ground water discharge area. This allows the Department to target mitigation water in areas of a local zone of impact where surface water flows are impacted by ground water discharge, where instream flow needs are not being satisfied, and where additional flows are needed.

The Department identifies the location (the zone of impact) in which a groundwater permit applicant must provide mitigation. This determination is made by considering the proposed well's proximity to surface water and to an area of groundwater discharge. The Department also considers well construction information, well depth and the portion of the aquifer that the well will water from, general ground water flow direction, and other hydrogeologic information. Using this information, the Department identifies whether the groundwater application must provide mitigation in the general zone of impact or in a local zone of impact.

The zones of impact are shown in Figure 12 and described as:

- General – In the Deschutes Basin above Lake Billy Chinook;
- Middle Deschutes River – In the Deschutes Basin above River Mile 125 on the Deschutes River;
- Crooked River – In the Crooked River subbasin above River Mile 13.8 on the Crooked River;
- Whychus Creek – In the Whychus Creek subbasin above River Mile 16 on Whychus Creek;
- Upper Deschutes River – In the Deschutes River basin above River Mile 185 on the Deschutes River;
- Little Deschutes River – In the Little Deschutes River subbasin above the mouth of the Little Deschutes River;
- Metolius River – In the Metolius River subbasin above River Mile 28 (the confluence with Jefferson Creek) on the Metolius River.

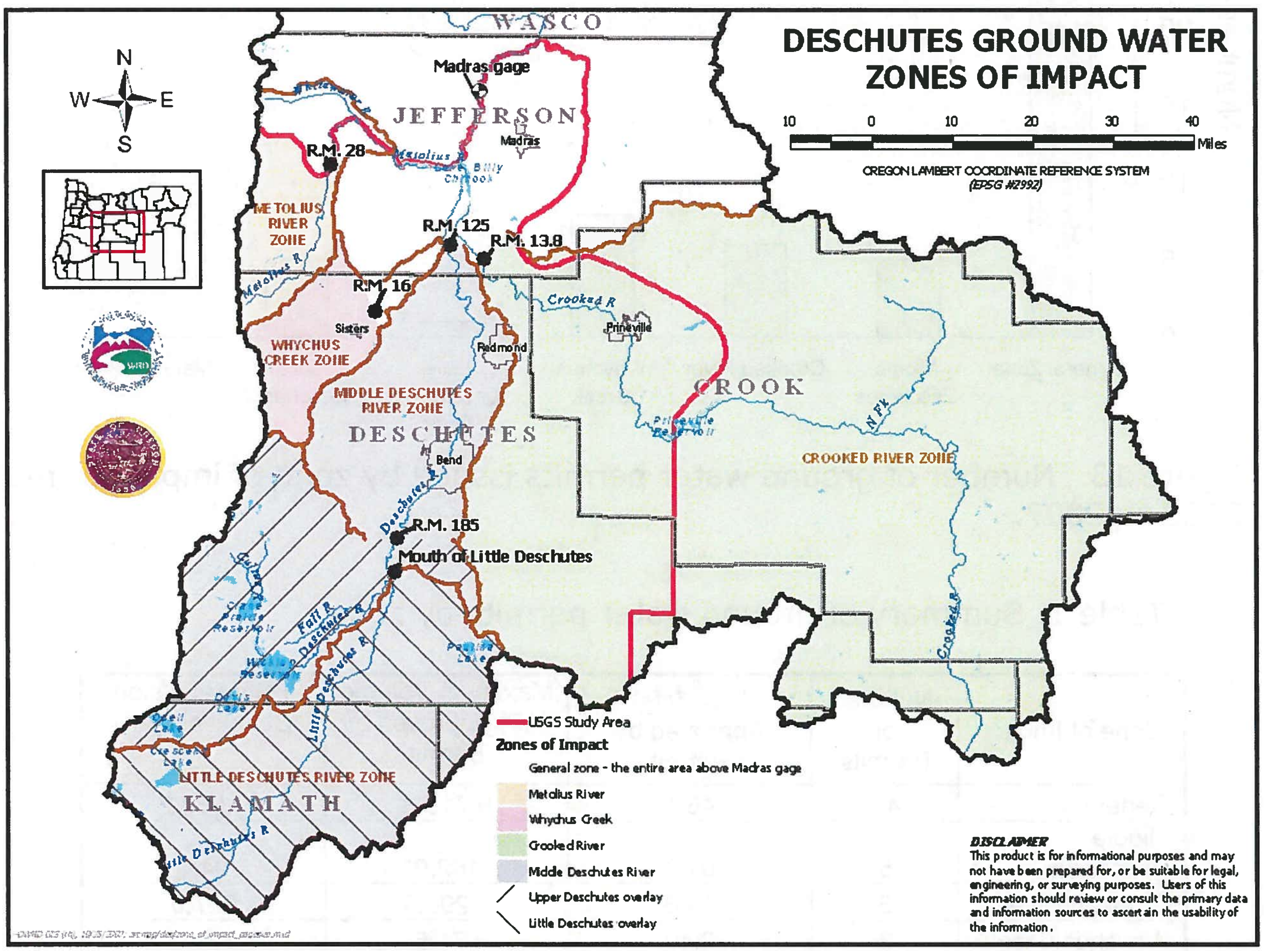


Figure 12. Map showing the location of each zone of impact identified by the Department.

As demonstrated in Figure 13, the majority of new ground water uses were found to have an impact on the General Zone of Impact. The quantity of permits by zone is shown in Table 1.

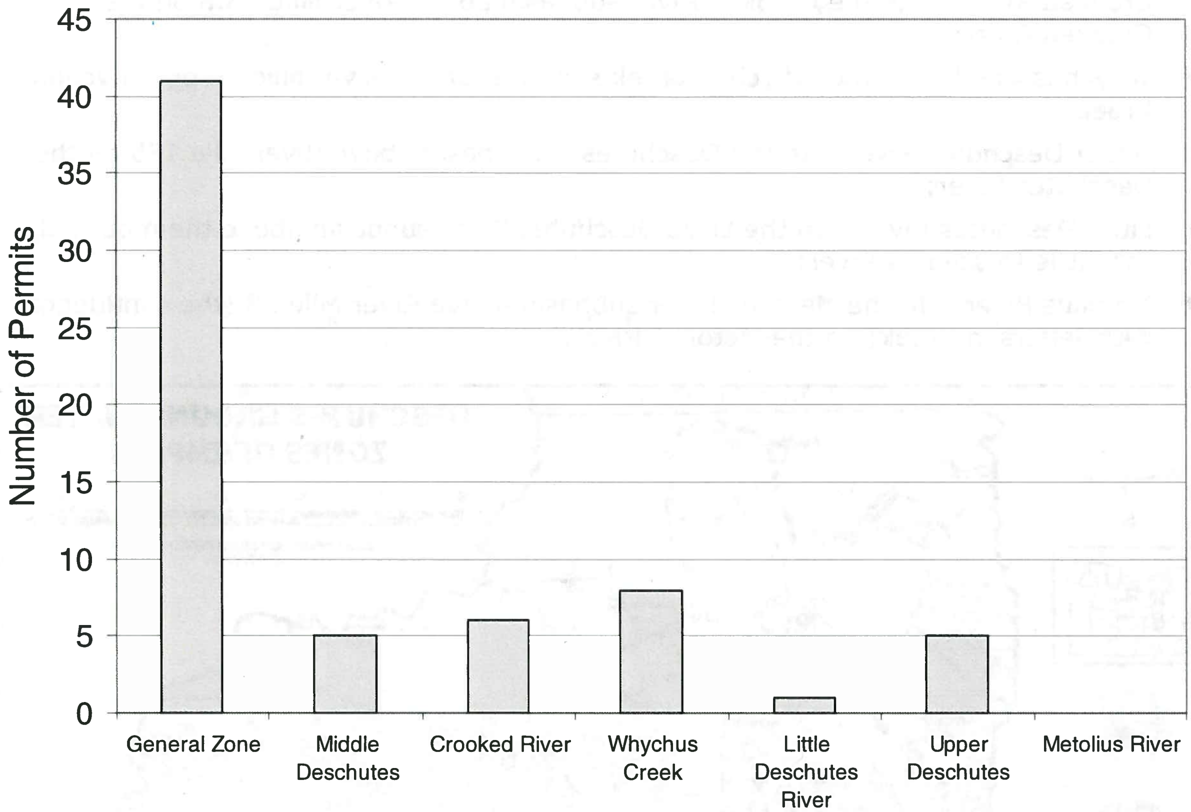


Figure 13. Number of ground water permits issued by zone of impact from 2003 to 2007.

Table 1. Summary of ground water permits by zone.

Zone of Impact	Number of Permits	Rate (cfs) Approved by Permit	Maximum Volume (AF) Approved by Permit	Total Mitigation Obligation (AF)
General	41	46.1	9,715.8	4,558.2
Middle Deschutes	5	0.67	162.0	94.1
Crooked River	6	1.93	1,295.5	527.0
Whychus Creek	8	2.40	571.5	321.2
Little Deschutes	1	0.22	159.3	0.0
Upper Deschutes	5	0.29	76.8	46.1
Metolius River	--	--	--	--
Totals	**66**	**51.6**	**11,980.8**	**5,546.6**

During the five years of the program, more mitigation than needed for each new ground water use has been provided in the appropriate zone of impact as described below and shown in the Figure 14.

General zone: The primary source of mitigation water in the General Zone is instream leases and some permanent instream transfers. Most of the mitigation water available in the General Zone of Impact originated in other upstream zones. Many of these mitigation projects have protected instream flows through the middle reach of the Deschutes River and down to Lake Billy Chinook. However, a few of the mitigation projects that established mitigation credits in the General Zone did not protect water instream into that zone but still provided instream benefits. For example, projects on Whychus Creek protected flows only to the mouth of Whychus Creek. While instream flows are not protected into the mainstem Deschutes, the flows in the Deschutes River at the confluence with Whychus Creek are at such a high level that there is still an instream benefit even considering downstream users.

As identified above, most mitigation projects in the General Zone originated in upstream zones of impact. For this reason, in part, there has been a steady supply of mitigation water in this zone. Another reason is urbanization. The General Zone encompasses an area supplied by large irrigation districts, containing expanding urban areas, and surface water rights that are more easily transferred or leased instream for mitigation purposes as the use of water on these lands changes over from agricultural to residential and other urban purposes.

Middle Deschutes: Only five new ground water permits have been approved in this zone. Mitigation projects generated in this zone established mitigation water (credits) for this zone and the General Zone of Impact. Some mitigation water was also generated by mitigation projects in upstream zones of impact, such as the Little Deschutes. The majority of the mitigation water was used to provide mitigation for uses in the General Zone of Impact and originated from a combination of instream leases and permanent instream transfers.

Like the General Zone, there has been a steady supply of mitigation credits in the Middle Deschutes Zone in part due to the urbanization of agricultural lands located in and around the cities of Bend and Redmond.

Whychus Creek: The amount of mitigation water generated in the Whychus Zone has generally increased each year, except in 2007. Mitigation projects in this zone of impact also generated mitigation water in the General Zone of Impact. Mitigation water was used by ground water permit holders in both zones.

Mitigation water in this zone has primarily originated from instream leases, which have generally been for one year periods, through the Three Sisters Irrigation District. There has only been one permanent instream transfer that established mitigation water in this zone.

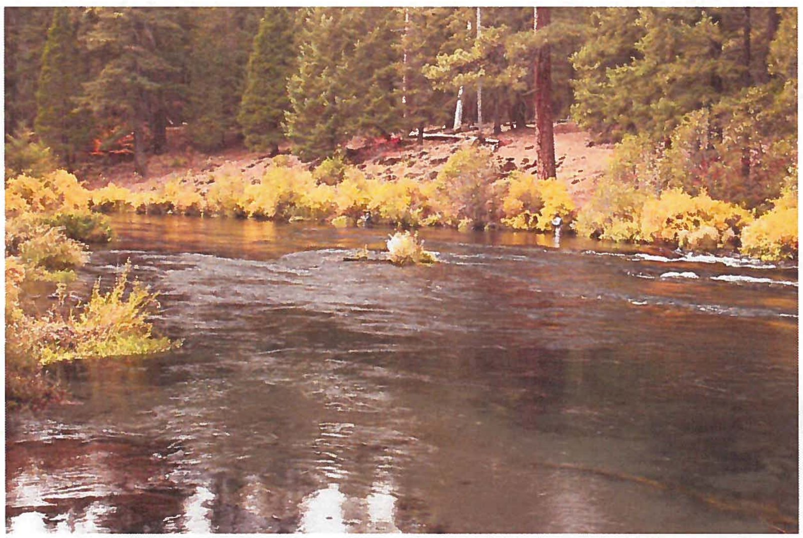
There may be fewer opportunities to generate mitigation water in this zone of impact and continued increase in supply of mitigation water is less certain than in the Middle Deschutes and General Zones of Impact. Land use in the Whychus Creek Zone of Impact tends to be more agricultural based and there is less urbanization.

Crooked River: The amount of mitigation water generated in the Crooked River Zone of Impact has fluctuated each year with no mitigation water available in the first year (2003) of the mitigation program. Mitigation water in this zone of impact has been more difficult to establish. Up until 2007, mitigation projects (two instream leases and one instream transfer) in this zone were generally small and with individual landowners. In 2007, North Unit Irrigation District along with the DWE Mitigation Bank requested that their annual instream lease be used (for the first time) to generate mitigation credits. Mitigation projects in this zone also generated mitigation water in the General Zone of Impact. Mitigation water was used by ground water permit holders in both zones.

Little Deschutes River: None of the mitigation water established in the Little Deschutes has been used to provide mitigation for new uses within this zone. Presently there is only one new ground water permit within this zone. This permit is for a non-consumptive use (commercial heat exchange) and has a mitigation obligation of zero acre feet. All mitigation projects within this zone have originated from instream leases. One mitigation project generated temporary mitigation credits in this zone in 2004. This project was terminated early by the Department due to regulatory issues. In 2006, another two instream lease applications established temporary mitigation credits in this zone. Credits from these projects were available for use as mitigation also within the Upper Deschutes, Middle Deschutes, and General Zones of Impact. Water from these projects was protected instream in the Little Deschutes River and into the mainstem Deschutes River. Credits from these projects were used to provide mitigation to ground water permits in the Upper Deschutes Zone of Impact.

Upper Deschutes: Mitigation credits for the Upper Deschutes Zone of Impact first became available in 2006 and are based upon instream leases. The mitigation projects that were used to establish mitigation in this zone did not originate in the Upper Deschutes area. The two projects that established mitigation in this zone originated in the Little Deschutes Zone of Impact. However, mitigation water (protected instream flows) provided instream benefits to flows in the impacted stream reach of the Upper Deschutes Zone of Impact.

Metolius River: To date, no mitigation projects have been proposed that would establish mitigation water within the Metolius Zone of Impact. No ground water applications to date have received notices of mitigation obligation within this zone.


Metolius River

Zone of Impact Summary

- *Majority of ground water mitigation provided in general zone of impact*
- *Mitigation provided in each zone met requirements for new ground water uses for each zone*
- *More than 39 cfs of instream flow as a result of permanent and temporary mitigation*

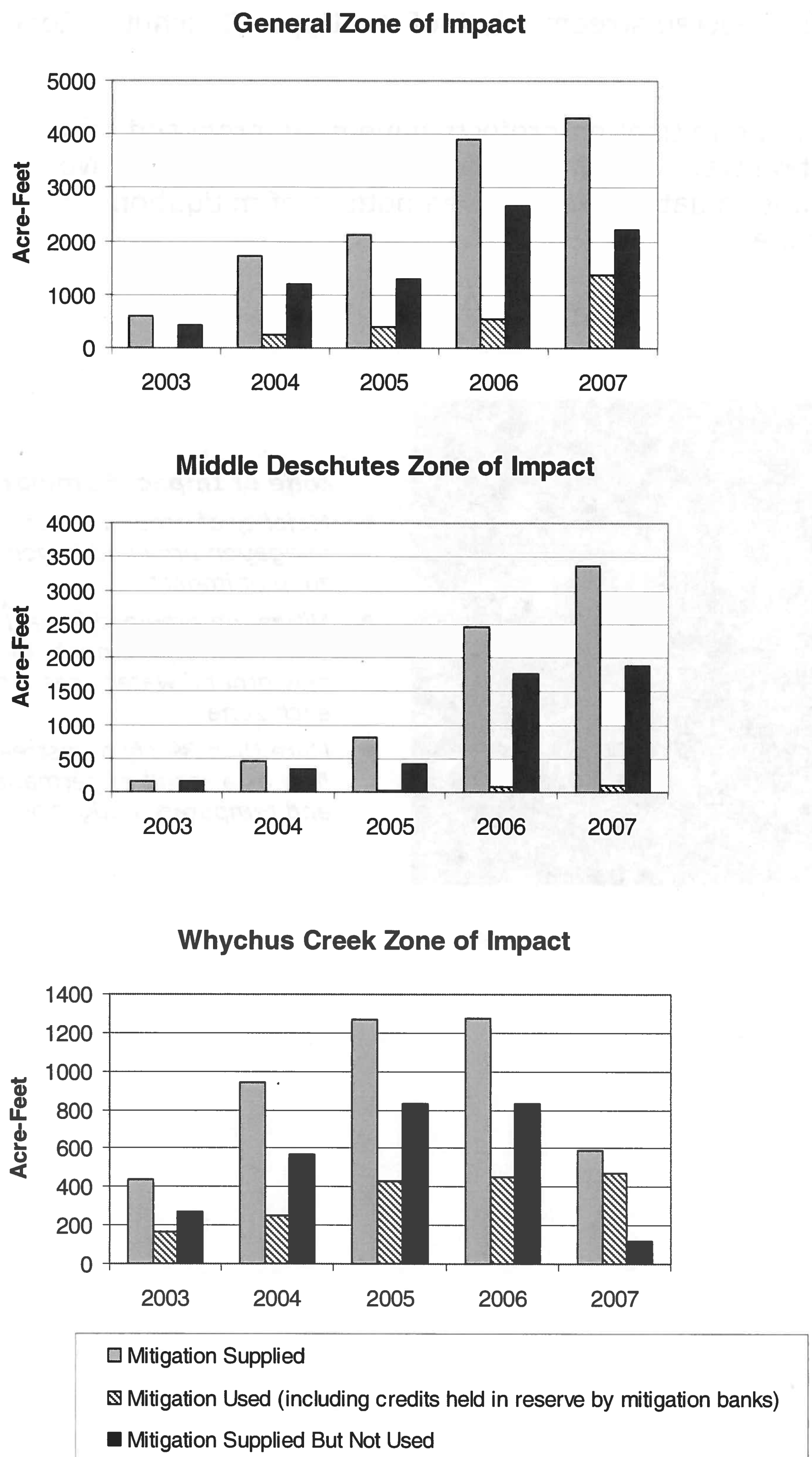


Figure 14. Total mitigation supplied and used for each zone by year.

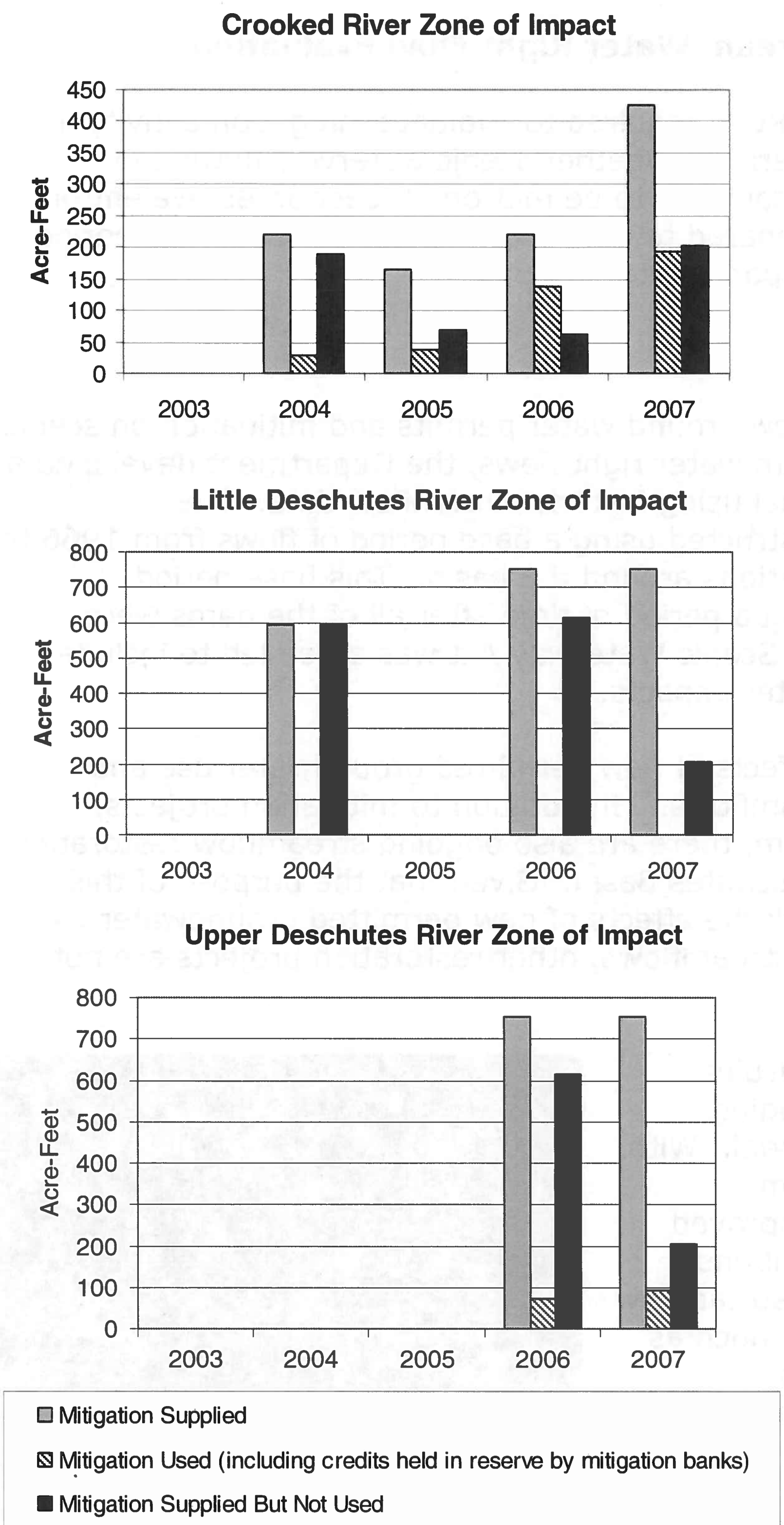


Figure 14 continued. Total mitigation supplied and used for each zone by year.

Scenic Waterway & Instream Water Right Flow Evaluation

On a five year cycle, the WRC is required to evaluate mitigation activity in the Deschutes Basin to determine whether scenic waterway flows and instream water right flows continue to be met on at least an equivalent or more frequent basis as compared to long-term, representative base period flows established by the Department.

<u>Instream Flow Model</u>

To monitor the impact of new ground water permits and mitigation on scenic waterway flows and instream water right flows, the Department developed a streamflow monitoring model using historic streamflow data. The streamflow model was constructed using a base period of flows from 1966 to 1995 at selected gaging stations around the basin. This base period represents river flows during a period of time after all of the dams were constructed and before the Scenic Waterway Act was amended to include consideration of ground water impacts.

The model considers the effects of new permitted groundwater use and mitigation projects on streamflows.[3] In addition to mitigation projects, which protect water instream, there are also ongoing streamflow restoration projects throughout the Deschutes Basin. Given that the purpose of this streamflow model is to track the effects of new permitted groundwater use and mitigation projects on streamflows, other restoration projects are not included in this model.

Table 2 shows the model results through mid-2007 for all gaging station sites used in the model. With only one exception, instream requirements are met or improved compared to base line conditions. Based on modeled results, streamflow overall has improved by as much as 27 cfs in some areas due to mitigation.

Gaging station on Deschutes River below Bend

[3] R.M. Cooper, Assessing the Impact of Mitigation on Stream Flow in the Deschutes Basin. Draft not yet available. Peer review scheduled in 2008.

Table 2. Modeled results showing baseline and changes in the percent of time instream requirements are met.

Gage Site	Base Line % Time Instream Requirements are met	Change in Percent of Time Instream Requirements are Met	Annual change in streamflow (cfs)
Deschutes River at Mouth	96.2	+0.02	1.17
Deschutes River below Pelton Dam	69.3	+0.59	1.17
Deschutes River Downstream of Bend	28.6	-0.36	15.2
Deschutes River Upstream of Bend	22.7	+2.34	27.3
Little Deschutes River at mouth	45.3	+3.55	8.74
Deschutes River below Fall River	63.5	0	0
Deschutes River below Wickiup	58.7	0	0
Metolius River at Lake Billy Chinook	99.7	0	0

Instream flows for the Deschutes River below Bend showed a slight decrease in the percent of time the instream flows are met. However, streamflows overall were increased by 15 cfs. The mitigation effects on streamflow for the reach below Bend are unique to the mitigation program in that the instream requirements are met less on a *percentage basis* after mitigation than before. This result is peculiar in that there is an overall *increase in stream flow* (i.e., *volume* of water increased) in the reach.

To understand why this seemingly conflicting result occurs, two facts related to the mitigation program need to be explained. First, mitigation debits (i.e., new groundwater withdrawals) produce a decrease in streamflow that is uniformly distributed over the year (Cooper 2008), while mitigation credits (e.g., instream transfers and leases) generally increase stream flow seasonally—during the irrigation season. Second, the instream requirements for the river below Bend are very close to historical flows during the winter, but the summer instream requirements far exceed historical flows (Figure 15).

Since mitigation produces a slight decrease in flow (~4 cfs or 0.6 percent) during winter (red line, Figure 15), and because the instream requirements are close to the historical flows, the decrease in flow also decreases the percent of time the mitigated flow meet the instream requirements.

Conversely, during summer, the instream requirements far exceed historical summer flows. Therefore, even though there is an increase in summer flows due to mitigation, the increase is of insufficient magnitude to increase the percent of time the instream requirements are met (Figure 15). The overall result is that the instream requirements are met less often during winter due to a decrease in flow, while the increase in flow during summer does not change the percent of time the instream requirements are met. This result occurs even though there is an overall increase in the annual flow below Bend.

Note that this trend of increasing streamflow overall, but decreasing the percent of time the instream requirements are met (annually) will continue until the mitigated summer flows reach the instream requirements (~250 cfs). At this point, this trend will reverse with the percent of time the instream requirements being met increasing with the overall increase in stream flow.

In the Whychus Zone of Impact, the Department installed an additional gage at Camp Polk Road in May 2007 to monitor groundwater inputs through springs. This gage is specifically designed to monitor localized impacts to the ground water system near Sisters and surrounding areas by local well pumping. In addition, the Department added a gage on the Metolius River just downstream of Camp Sherman to monitor similar effects. Lastly, the USGS and the US Department of Interior's Bureau of Land Management installed a gage on the Crooked River near Osborne Canyon some years ago to additionally monitor ground water fluxes in that reach of river.

<u>Real-time Streamflow Records</u>

The Department primarily uses a database and streamflow model to monitor the effectiveness of the mitigation program. However, over time, yearly real-time streamflow records can also be tracked at appropriate gaging stations or other measurement locations. In the short term, streamflow data will not provide information on how the system is responding, given changes in climatic conditions and other variables. It is not possible to correct real-time data for effects of year-to-year changes in weather (or other variables) with sufficient accuracy. In addition, it may be years before the effects of mitigation activities and ground water use reach equilibrium though trends may become apparent over a longer period of time.

Because of the variability of the system, streamflow records will not be able to detect changes due to mitigation activity. One exception is the Deschutes River below Bend which a combination of mitigation, conservation, flow restoration, and changes in water management are detectable. This is shown in Figure 15.

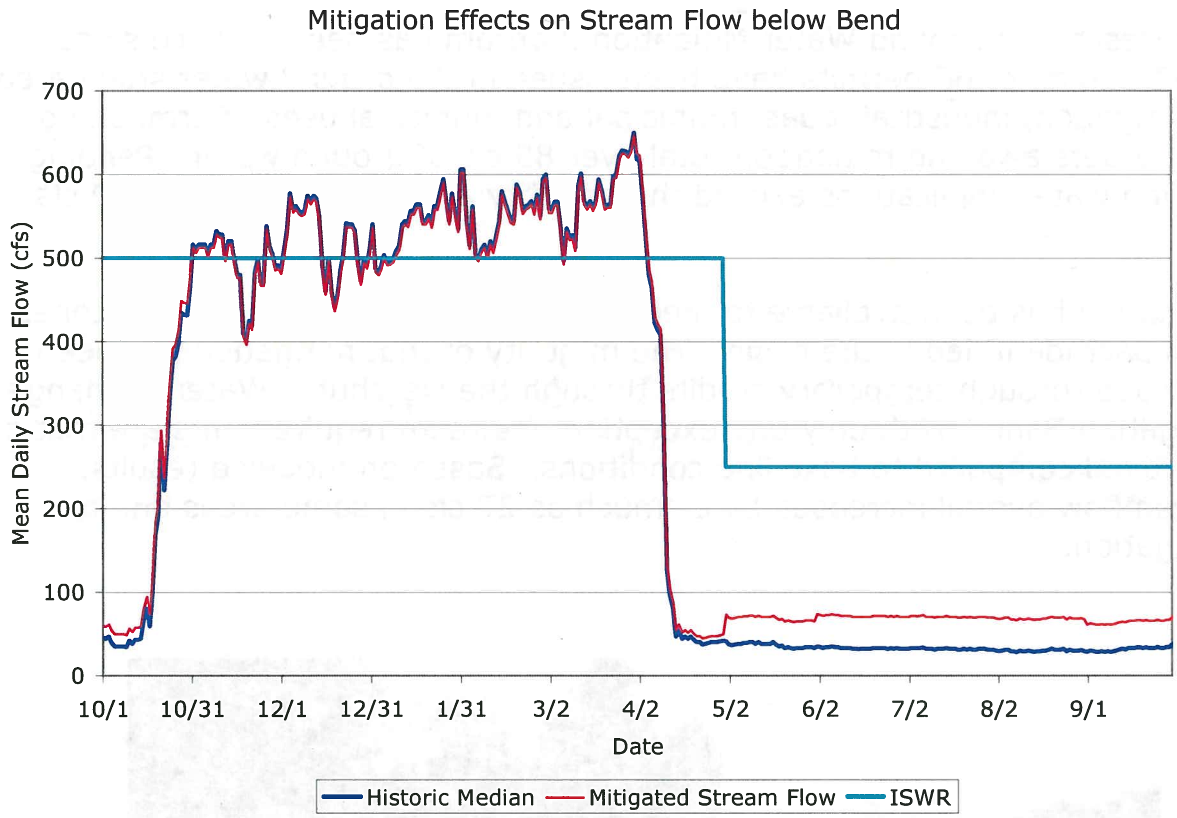


Figure 15. Historical median flows (base period flows) and mitigated streamflow in cubic feet per second on the Deschutes River below Bend compared to instream requirements.

Streamflow Summary

- *In general, instream requirements are being met or have been improved as compared to base line conditions.*

- *Based on modeled results, streamflow overall has improved by as much as 27 cfs in some areas due to mitigation.*

Summary

The Deschutes Ground Water Mitigation Program has been in place since 2002. To date, 66 permits have been issued in the ground water study area for irrigation, industrial, quasi-municipal and municipal uses. Permits and final orders awaiting mitigation total over 85 cfs of ground water. Pending ground water applications exceed the quantity available under the 200 cfs cap.

Mitigation has been available to meet the needs of new permits in all zones of impact identified in the basin. The majority of that mitigation has been provided through temporary credits through the Deschutes Water Exchange Mitigation Bank. With only one exception, instream requirements are met or improved compared to base line conditions. Based on modeled results, streamflow overall increased by as much as 27 cfs in some areas due to mitigation.

Evaluation Summary

- *66 new ground water permits have been issued since the Mitigation Program was adopted by the Commission.*
- *42% of the 200 CFS cap has been allocated under final orders and new ground water permits.*
- *Pending applications exceed the remaining balance of the 200 CFS cap.*
- *Mitigation established each year has consistently exceeded the amount needed (including for reserves) on average by 66%.*
- *In the first five years of the mitigation program, mitigation has been provided solely by instream leases and instream transfers.*
- *Temporary mitigation credits established from instream leases has consistently provided sufficient mitigation to meet ground water permit needs and reserves.*
- *Each year, the cumulative amount of permanent mitigation provided by instream transfers has increased.*
- *The majority of ground water mitigation has been provided in the general zone of impact.*
- *Mitigation provided in each zone met requirements for new ground water uses for each zone.*
- *More then 39 CFS of instream flow as a result of permanent and temporary mitigation.*
- *Scenic waterway and instream water right flows are met or have been improved as compared to base period flows.*
- *Overall streamflows have been improved by as much as 27 CFS in some areas due to mitigation.*

Attachment 3

Assessing the Impact of Mitigation on Stream Flow in the Deschutes Basin

Open File Report SW 08-001

State of Oregon
Water Resources Department

Assessing the Impact of Mitigation on Stream Flow in the Deschutes Basin

By Richard M. Cooper

State of Oregon
Water Resources Department

Open File Report SW 08-001

Salem, Oregon
November 2008

Cover photograph: The Deschutes River, courtesy of g. white.

Contents

Introduction 1

A Mathematical Model 1

Resolution of the Model 2

In-stream Flow Requirements 4

Modeling Versus Real Time Monitoring of Stream Flow 4

Modeling the Groundwater Surface Water Interaction 5

Description of the Mathematical Model 11

Mitigation 19

Groundwater Withdrawals 20

Zone of Impact Determination 20

Groundwater Rights with the 7J Condition 21

Assumptions of the Model 21

Short Comings of the Model 22

References 22

Appendix A – Leases and Transfers 23

Appendix B – Groundwater Withdrawals 33

Appendix C – Appendix C - Zone of Impact Determination for a Mitigation Project *By* Jonathan L. La Marche 39

Appendix D - Zone Of Impact Determination for a Groundwater Withdrawal *By* Kenneth E. Lite, Jr. 43

Figures

Figure 1. Deschutes Basin locations where the impacts of mitigation activities are accumulated or analyzed 7

Figure 2. General zone of impact 12

Figure 3. Crooked River zone of impact 13

Figure 4. Metolius River zone of impact 14

Figure 5. Whychus Creek zone of impact 15

Figure 6. Middle Deschutes River zone of impact 16

Figure 7. Upper Deschutes River zone of impact 17

Figure 8. Little Deschutes River zone of impact 18

Figure A-1. Where the diversion and the zone of impact are both on the Deschutes River, showing the conceptual models for the cases before (A) and after (B) implementation of a lease or transfer 28

Figure A-2. Where the diversion is on the Deschutes River and the zone of impact is on the Crooked River, showing the conceptual models for the cases before (A) and after (B) implementation of a lease or transfer 29

Figure A-3. A simplified schematic showing the change in streamflow for various reaches of the Deschutes and Crooked Rivers as a result of the in-stream lease given in the example... 32

Figure B-1. Where the diversion and the zone of impact are both on the Deschutes River, showing the conceptual models for the cases before (A) and after (B) implementation of a groundwater withdrawal 34

Figure B-2. Where the diversion is on the Deschutes River and the zone of impact is on the Crooked River, showing the conceptual models for the cases before (A) and after (B) implementation of a groundwater withdrawal 35

Figure B-3. A simplified schematic showing the change in streamflow for various reaches of the Deschutes and Crooked Rivers as a result of the groundwater withdrawal given in the example 38

Figure C-1. A map showing the locale near the place of use (POU) for a water right for irrigation that is to be leased in-stream 41

Tables

Table 1. Locations on the Deschutes River and its tributaries where streamflow impacts are accumulated 3

Table 2. Deschutes Basin "analysis locations" where the effect of mitigation activities on the frequency in-stream requirements are met may be evaluated 5

Table 3. An example illustrating the difference between additive instream requirements (i.e., instream transfers and leases) and non-additive instream requirements (i.e., instream water rights, scenic waterways, and tribal agreements) 8

Table 4. In-stream requirements at each of the eight analysis locations in the Deschutes Basin...... 9

Table 5. Percent of days the in-stream requirement is met annually in the Deschutes River below Pelton Dam (Gaging Station 14092500) 10

Table 6. The zones of impact and their associated watersheds 11

Table 7. Percent of days the in-stream requirement is met by month in the Deschutes River below Pelton Dam (Gaging Station 14092500) for the period, water years 1966 to 1995 19

Table A-1. An example of an in-stream transfer showing the amount diverted annually, the consumptive use and the return flows associated with the original water right, the seasonal distribution of the in-stream flow requirements, and the stream reaches where the requirements are applied 24

Table A-2. Examples showing the effect on streamflow of a change in in-stream requirement with and without the presence of users able to divert the unprotected water 25

Table A-3. Examples showing the effect on streamflow of the loss of return flow with and without an in-stream requirement and with and without the presence of users able to divert any unprotected water. 25

Table A-4. The numerical model for a transfer or lease 26

Table A-5. Model assumptions for a transfer or lease 27

Table A-6. The required model input for a transfer or lease ... 27
Table A-7. Estimated impact from a mitigation project on streamflow for four stream reaches in the Deschutes River basin ... 31
Table B-1. The numerical model for groundwater withdrawals ... 36
Table B-2. Model assumptions for groundwater withdrawals ... 36
Table B-3. The required model input for groundwater withdrawals ... 36
Table B-4. Estimated impact from a mitigated groundwater withdrawal on streamflow for four stream reaches in the Deschutes River basin ... 37
Table C-1. Information required for the determination of the zone of impact affected by a proposed mitigation project ... 40

Acknowledgments

Many thanks are due Ken Stahr for creating the maps used in this report. Jonathan La Marche and Laura Snedaker of the Oregon Water Resources Department and Marshall Gannett of the U.S. Geological Survey reviewed the report and made many valuable observations and criticisms. The report was greatly improved through their efforts.

Assessing the Impact of Mitigation on Streamflow in the Deschutes Basin

By Richard M. Cooper

Introduction

Surface water in the upper Deschutes Basin is over-appropriated in most areas at most times of the year.[1] As a result, opportunities for new surface water appropriation in the basin are limited, and attention has turned to groundwater as a source for new appropriations. However, groundwater and surface water are directly linked in the Deschutes Basin (Sceva, 1960, 1968; Gannett and others, 2001). For many streams, groundwater discharge to surface water is the primary source of streamflow. Where this is the case, withdrawals from groundwater have a direct impact on streamflows.

In order to prevent further diminishment of the surface water resource due to groundwater withdrawals, the Oregon Water Resources Commission adopted the Deschutes Groundwater Mitigation Rules (OAR Chapter 690, Division 505) in September 2002. The rules require that new allocations of groundwater be mitigated to counter their effect on surface water flow. Because it is expected that the activities allowed under the rules will still have some effect on streamflow and may impact how often in-stream flow requirements are met, the rules require that the Oregon Water Resources Department (OWRD) monitor and evaluate the effects of mitigation and groundwater allocation on streamflow throughout the basin. Specifically, the OWRD is required to "determine whether scenic waterway flows and in-stream water right flows in the Deschutes Basin continue to be met on at least an equivalent or more frequent basis as compared to long-term, representative base period flows established by the Department" (OAR 690-505-0500(3)).

To make this evaluation, the impacts of groundwater withdrawals and mitigation projects on streamflow are characterized as changes in the frequencies the various in-stream flow requirements are met. Streamflow impacts may have either a positive or negative effect on these frequencies depending on the type of activity, location, and season of the year. Summed at specified locations, the changes in frequency are a quantitative measure of the effectiveness of the mitigation program.

The "before mitigation" or baseline condition of streams in the Deschutes Basin is determined from streamflows measured during water years 1966 to 1995. This base period is after all reservoirs were built and before the Department included a condition on groundwater permits providing for possible regulation under the State Scenic Waterway Act, i.e., the so called "7J condition" (OAR 690-310-260 (9)(g)). Water rights with the 7J condition are discussed in a later section. With the adoption of the mitigation rules, the OWRD now adds a further condition that a groundwater right issued with mitigation will not be subject to regulation as long as the mitigation is maintained.

A Mathematical Model

A computer program has been developed by the OWRD to mathematically estimate (i.e., model) the *change* in streamflow expected due to mitigation and groundwater allocation. The model then determines if these streamflow impacts will change the frequency with which in-stream flow requirements in the basin are met.

In the model, it is possible to estimate the streamflow impacts due to mitigation and groundwater allocation at numerous locations. However, determining if these impacts change the frequency with which the in-stream flow

---

[1] Over-appropriation is defined in the Water Allocation Policy adopted by the Water Resources Commission in July 1992. Refer to OAR 690-400-010(11)(a)(A). For further discussion, see Cooper, 2002.

requirements are met is possible only where a long term and continuous record of historic streamflow is available. For these "analysis locations", the historic time series is modified by the streamflow impacts accumulated for that location. Then the percent of time the in-stream flow requirements are met is calculated for both the original and the modified time series allowing changes in frequency due to streamflow impacts to be determined.

Whether an in-stream flow requirement is met is determined on a daily basis (using *mean* daily flows as the basis for comparison) and is reported as the percent of days the in-stream flow requirements are met both monthly and annually. Output from the model includes the accumulated impacts on streamflow at many locations, and where possible, the expected changes in the frequencies with which the in-stream flow requirements are met. These statistics are reported monthly and annually.

Resolution of the Model

The mathematical model is based on the methodology the OWRD uses to assess water availability (Cooper, 2002). In that methodology, a large basin such as the Deschutes is divided into a number of subunits called Water Availability Basins or WABs. Each WAB represents a watershed and is identified by the location of its 'pour point' or outlet (e.g., Deschutes River above Tumalo Creek). In addition, each WAB has a unique identification number. For this report, the WABs are referred to simply as watersheds.

The Deschutes Basin is divided into 184 watersheds; 50 of which are of interest here. Each of these 50 watersheds is shown in Table 1 along with its identification number and a 'key number' that may be used to locate the watershed pour point on the various maps used in this report. Using the water availability methodology, the streamflow impacts due to the various mitigation activities are determined and then accumulated at the watershed pour points. The stretches of the streams between watershed pour points are referred to as 'stream reaches' or simply 'reaches'.

The degree to which mitigation impacts can be evaluated depends on the availability of historic streamflow data. For all watershed pour points where streamflow impacts are accumulated, a report may be generated detailing the monthly and annual changes in streamflow expected to occur. These expected changes show clearly whether streamflows are increasing or decreasing due to mitigation activities, allowing a qualitative evaluation of the impact mitigation is having on streamflow. To make the more rigorous assessment of the impact of the changes in streamflow on the frequency the in-stream flow requirements are met requires knowledge of the streamflows that occurred at those locations during the base period. Unfortunately, for most watershed pour points, these streamflows are unknown. In those few locations where suitable streamflow records are available, however, the rigorous assessment can be made.

The impact of the various mitigation activities on the percent of time in-stream flow requirements are met may be evaluated only where a continuous time series of mean daily streamflows is available for the period 1966 to 1995. There are eight such locations on the Deschutes River and its tributaries suitable for making this assessment. Streamflow at each of these analysis locations may be represented by records from a single station or a combination of stations.

At three locations, the gaging station is upstream of the pour point of the watershed where the streamflow impacts are accumulated: 1) the Deschutes River below Bend), 2) the Little Deschutes River, and 3) the Deschutes River above the Little Deschutes River. In each case, some error occurs in assessing the impact on the frequency the in-stream flow requirement is met because inflows between the gaging station and the pour point are not accounted for. The effect on the analysis is to underestimate the amount of time the in-stream flow requirements are met. For the later two locations, for the base period, the unaccounted inflows are small compared to main stem flows. The associated errors are therefore also small. For the first location, however, while unaccounted inflows are small compared to main stem flows in the summer, they may be a significant part of winter flows (Jonathan LaMarche, OWRD hydrologist, personal communication, 2008).

Table 1. Locations on the Deschutes River and its tributaries where streamflow impacts are accumulated. Locations are at the pour points of the specified watersheds.

Map Key	Watershed ID #	Watershed Name
1	70087	Deschutes River at mouth
2	30530616	Deschutes River above White River
3	30530627	Deschutes River above Eagle Creek
4	30530637	Deschutes River above Warm Springs River
5	30530643	Deschutes River below Pelton Dam
6	30530101	Metolius River at mouth
7	30530102	Juniper Creek at mouth
8	30530103	Big Canyon at mouth
9	70761	Fly Creek at mouth
10	70755	Spring Creek at mouth
11	30530104	Street Creek at mouth
12	70698	Metolius River above Street Creek
13	30530105	Whitewater River at mouth
14	70697	Jefferson Creek at mouth
15	70694	Candle Creek at mouth
16	30530116	Metolius River above Candle Creek
17	70766	Abbot Creek at mouth
18	70693	Canyon Creek at mouth
19	70699	Metolius River above Canyon Creek
20	70354	Crooked River at Lake Billy Chinook
21	30530508	Crooked River above Osborne Can
22	30530501	Dry River at mouth
23	30530507	Crooked River above Dry River
24	70595	McKay Creek at mouth
25	70611	Ochoco Creek at mouth
26	30530506	Dry Creek at mouth
27	70606	Bear Creek at mouth
28	70353	Crooked River above Prineville Reservoir
29	70357	North Fork Crooked River at mouth
30	73199	Crooked River above North Fork Crooked River
31	70695	Deschutes River above Lake Billy Chinook
32	70753	Whychus Creek at Mouth
33	70760	Indian Ford Creek at mouth
34	70754	Whychus Creek above Indian Ford Creek
35	30530112	Deschutes River above Buckhorn Canyon
36	70752	Tumalo Creek at mouth
37	197	Deschutes River above Tumalo Creek
38	30530114	Deschutes River above COID Diversion
39	30530138	Deschutes River at Benham Falls
40	73329	Spring River at mouth
41	198	Deschutes River above Spring River
42	70757	Little Deschutes River at mouth
43	30530202	Paulina Creek at mouth
44	30530203	Long Prairie Slough at mouth
45	70765	Crescent Creek at mouth
46	70758	Little Deschutes River above Crescent Creek
47	199	Deschutes River above Little Deschutes River
48	70762	Fall River at mouth
49	73325	Browns Creek at mouth
50	70764	Deschutes River above Browns Creek

Several other long-term gaging stations are located in the Deschutes Basin but are not considered for analysis. Although these gaging stations occur in river reaches with in-stream flow requirements, they are not suitable for either of two reasons: 1) streamflow at the gaging station does not adequately represent streamflow for the reach (e.g., there are unaccounted for diversions), or 2) the station is high in the watershed and impacts from mitigation or groundwater withdrawals are not expected.

The eight analysis locations are shown in Table 2 and on Figure 1.

In-stream Flow Requirements

Each of the eight analysis locations is in a river reach affected by one or more in-stream flow requirements. For this discussion, in-stream flow requirements are divided into two types: additive and non-additive.

For non-additive in-stream flow requirements, at locations with more than one requirement, the effective requirement is the largest of the requirements – the requirements do not sum. Non-additive in-stream flow requirements may be the result of an in-stream water right (ISWR)[2], a scenic waterway (SWW), or a treaty with the Warm Spring Tribes (Treaty).

Additive in-stream flow requirements result from the lease, transfer, or allocation of conserved water from an out-of-stream water right to an in-stream water right. These requirements are additive among themselves, but are not additive with the various types of non-additive in-stream flow requirements. Generally, an additive in-stream water right is much smaller than a non-additive in-stream flow requirement and has an earlier priority date. When occurring in the same stream reach, an additive in-stream water right replaces only a portion of a non-additive in-stream flow requirement. The benefit to the stream derives from the earlier priority date of the additive water right. These concepts are illustrated by a hypothetical example in Table 3.

The resultant in-stream flow requirements for the eight locations are given in Table 4.

Modeling Versus Real Time Monitoring of Streamflow

It is sometimes suggested that the effects of mitigation and groundwater allocation be determined by real time monitoring of streamflow rather than use of a mathematical model. Real time monitoring of streamflows is not used for three reasons: 1) there must be a basis for comparison, 2) it may take many years for the effects of a mitigation project or a groundwater allocation to be fully realized, and 3) activities in the basin other than mitigation may affect streamflow. Each of these reasons is discussed in detail.

Reason 1 Evaluation of the effects of mitigation and groundwater withdrawals on streamflow requires a comparison of streamflows occurring with and without these activities. Although a comparison could be made using streamflow measurements made before and after the initiation of mitigation and groundwater withdrawals, the comparison would not be useful. The changes in streamflow due to mitigation and groundwater withdrawals are expected to be small compared to natural variation in streamflow due to changes in weather from season to season and year to year. The small changes would be masked by the much larger natural variations, and there would be no way to distinguish between the two types of change. Unfortunately there is no good way to remove or compensate for the natural variation.

Table 5 illustrates the magnitude of the natural variations in streamflow likely to occur. It shows the percent of days the in-stream flow requirement was met at the USGS gaging station located on the Deschutes River just below Pelton Dam near Madras for the period 1966 to 1995. The percent of days varies from 28.8 percent in 1992 to 100 percent in 1984.

---

[2] Non-additive in-stream water rights may be established under the state agency in-stream water right application process (ORS 537.341) or conversion of minimum perennial streamflow to an in-stream water right (ORS 537.346).

Table 2. Deschutes Basin "analysis locations" where the effect of mitigation activities on the frequencies with which in-stream flow requirements are met may be evaluated.

Map Key	Location	Representative Gaging Station(s)	Associated Watershed
A	Deschutes River at the mouth	14103000	70087
B	Deschutes River below Pelton Dam	14092500	30530643
C	Metolius River at Billy Chinook	14091500	70698
D	Deschutes River downstream of Bend	14070500	30530112
E	Deschutes River upstream of Bend	14070500 + 4 canals *	197
F	Deschutes River at Benham Falls	14064500	30530138
G	Little Deschutes River at mouth	14063000	70757
H	Deschutes River above Little Deschutes River	14056500 + 14057500 **	199

* The four canals are the DCMID (14068500), the North Unit Main (14069000), the North (14069500), and the Swalley (14070000).

** 14056500 is the Deschutes River below Wickiup Reservoir near La Pine, OR, and 14057500 is Fall River near La Pine, OR.

Reason 2 The effects of some mitigation projects and groundwater allocations may not be fully realized for many years. Some delay results from the time it takes to implement these activities, but more so because of the time it takes for changes to propagate through the groundwater system. Gannett and Lite (2004) demonstrate that the effects of ground-water pumping on streamflow accumulate over a period of weeks or decades depending on the location of pumping. This time delay means that decisions about new mitigation or groundwater allocation could be made with the effects of existing mitigation or allocation either over- or under-estimated, respectively. Using a model based on historic streamflow provides a basis for comparison and allows the effects of mitigation to be computed at full realization.

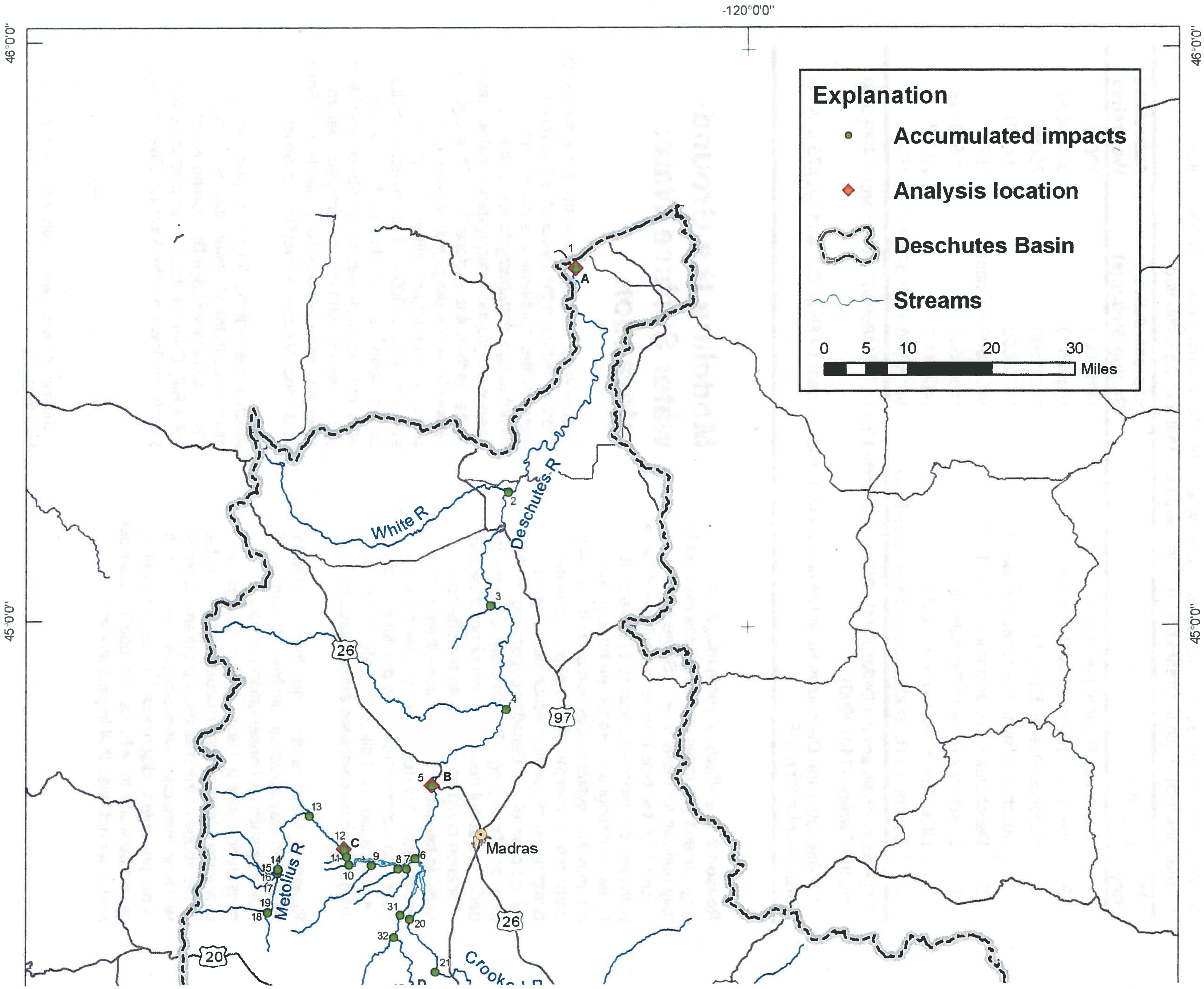
Reason 3 Activities other than those related to mitigation may affect streamflow. A number of activities such as conservation projects, conserved water projects, aquifer storage, or allocation of stored water could happen outside of the scope of the mitigation program. Even if real time monitoring were otherwise possible, it is not possible to discriminate in the streamflow record between the effects of mitigation activities and other activities that impact streamflow.

Modeling the Groundwater Surface Water Interaction

Groundwater and surface water are significantly interconnected in the Deschutes Basin with groundwater discharge to surface water contributing substantially to streamflow. A basin-wide groundwater system provides much of the discharge to surface flow. This regional system is recharged primarily from three sources (Gannett and others, 2001): 1) on average about 3,500 cfs from direct precipitation on the basin[3], 2) an estimated 850 cfs from adjacent basins by way of inter-basin flow, and 3) on average, 490 cfs from irrigation return flows and canal leakage for projects near Bend, Redmond, Madras, Prineville and Sisters.

Much of the regional flow of groundwater discharges to the Crooked and Deschutes Rivers just above Lake Billy Chinook and to Lake Billy Chinook itself. This discharge plus the streamflow from the Metolius River average

[3] Almost all of this recharge occurs in the Cascade Mountains.


-120°0'0"
46°0'0"
45°0'0"
Explanation
Accumulated impacts
Analysis location
Deschutes Basin
Streams
0 5 10 20 30 Miles
Deschutes R
White R
Metolius R
Madras
A
B
C
26
97
20
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
31
32

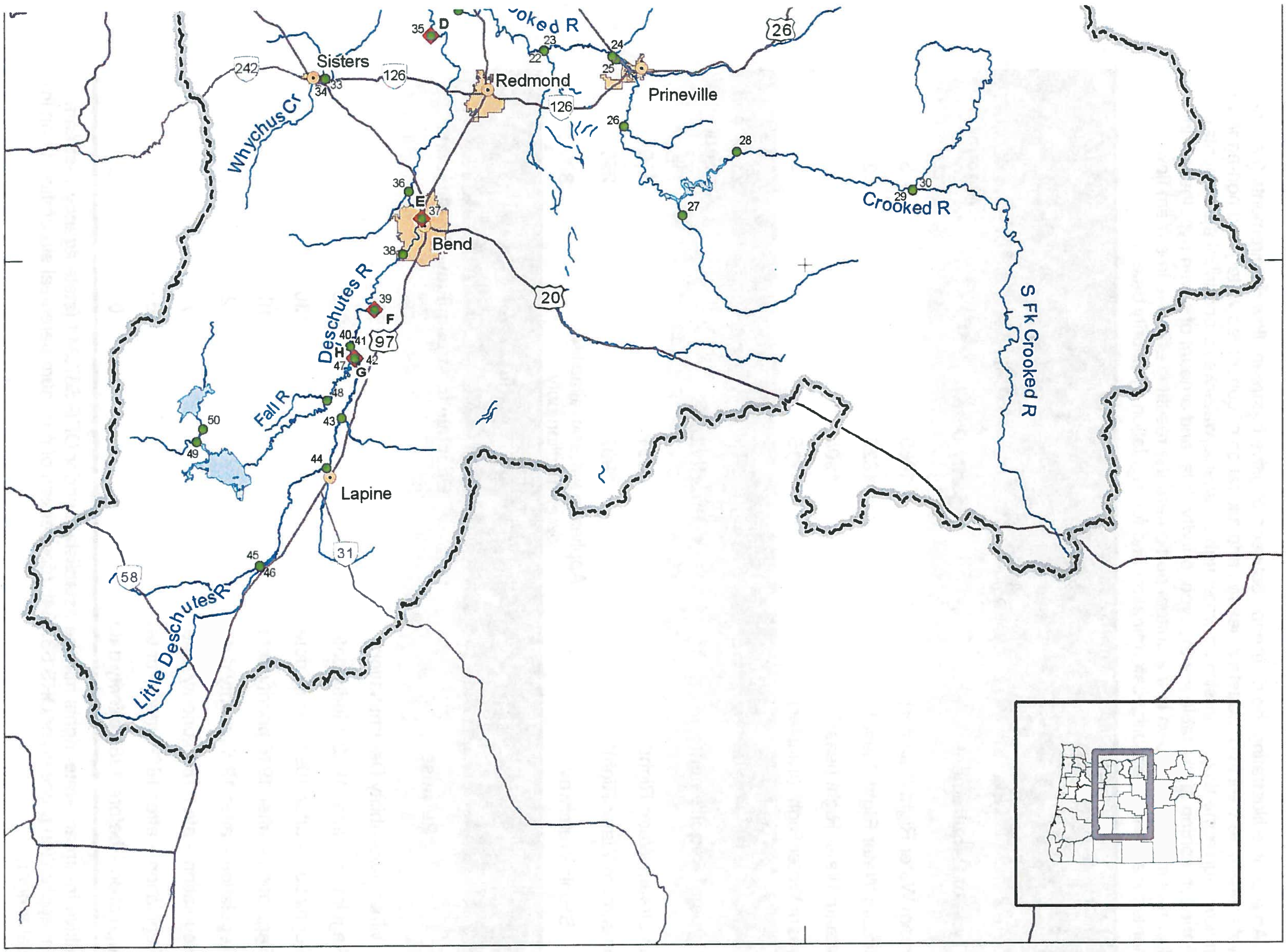


Figure 1. Deschutes Basin locations where the impacts of mitigation activities are accumulated or analyzed. See Table 1 for a map key to accumulated impacts and Table 2 for a map key to the analysis locations.

Table 3. An example illustrating the difference between additive in-stream flow requirements (i.e., in-stream water rights derived from transfers, leases and allocation of conserved water) and non-additive in-stream flow requirements (i.e., in-stream water rights*, scenic waterways, and tribal agreements). Shown in the top portion of the table are the type, priority date, and amount of seven hypothetical in-stream flow requirements. Shown in the bottom portion are the resulting effective in-stream flow requirements for a water availability determination and for regulation by priority date.

In-stream Flow Requirements		
Additive		
Type of Requirement	**Priority Date**	**Amount** cfs
In-stream Water Right (transfer)	1889	5
In-stream Water Right (lease)	1895	2
In-stream Water Right (lease)	1905	5
In-stream Water Right (transfer)	1915	4
Non-Additive		
Type of Requirement	**Priority Date**	**Amount** cfs
In-stream Water Right*	1991	150
In-stream Water Right*	1992	250
Scenic Waterway	Applies to water availability determination only	300

Effective In-stream Flow Requirements	
Purpose	**Effective In-stream Flow Requirement** cfs
Water Availability Determination	300
Regulation – after 1992 priority date	250
Regulation – after 1991 priority date	150
Regulation – after 1915 priority date	16
Regulation – after 1905 priority date	12
Regulation – after 1895 priority date	7
Regulation – after 1889 priority date	5
Regulation – before 1889 priority date	0

*Non-additive In-stream water rights may be established under ORS 537.341 (state agency in-stream water right application process) or ORS 537.346 (conversion of minimum perennial streamflow to an in-stream water right).

Table 4. In-stream flow requirements at each of the eight analysis locations in the Deschutes Basin.

Gage(s)	**14103000** Deschutes River at the mouth	**14092500** Deschutes River below Pelton Dam	**14091500** Metolius River at Lake Billy Chinook	**14070500** Deschutes River downstream of Bend	**14070500 + 4 canals** Deschutes River upstream of Bend	**14064500** Deschutes River at Benham Falls	**14064500 + 14057500** Deschutes River above Little Deschutes River	**14063000** Little Deschutes River at mouth
Type of in-stream flow requirement	**SWW**	**SWW**	**Treaty**	**SWW**	**SWW**	**SWW**	**SWW**	**ISWR**
Zone of impact	**N/A**	**General**	**Metolius River**	**Middle Deschutes River**	**Middle Deschutes River**	**Upper Deschutes River**	**Upper Deschutes River**	**Little Deschutes River**
	In-stream flow requirements in cubic feet per second							
Jan	4500	4500	1150	500	660	660	400	200
Feb	4500	4500	1150	500	660	660	400	200
Mar	4500	4500	1160	500	660	1000	400	236
Apr	4000	4000	1160	500	660	1000	500	240
May	4000	4000	1240	250	660	1600	500	240
Jun	4000	4000	1200	250	660	1600	500	200
Jul	4000	4000	1170	250	660	1600	500	126
Aug	3500	3500	1140	250	660	1600	500	74.5
Sep	3500	3500	1100	250	660	1600	500	92.2
Oct	3800	3800	1080	500	660	1000	500	116
Nov	3800	3800	1140	500	660	660	400	164
Dec	4500	4500	1110	500	660	660	400	196

Table 5. Percent of days the in-stream requirement is met annually in the Deschutes River below Pelton Dam (Gaging Station 14092500).

Year	Percent of days per year	Average number of days per year
1966	58.1	212
1967	53.7	196
1968	35.0	128
1969	56.4	206
1970	66.6	243
1971	84.9	310
1972	94.3	344
1973	63.3	231
1974	95.1	347
1975	99.7	364
1976	99.7	364
1977	54.0	197
1978	82.2	300
1979	69.9	255
1980	59.3	216
1981	64.9	237
1982	99.7	364
1983	99.5	363
1984	100.0	365
1985	94.2	344
1986	92.9	339
1987	80.0	292
1988	59.3	216
1989	69.9	255
1990	45.2	165
1991	28.8	105
1992	28.7	105
1993	59.2	216
1994	31.0	113
1995	54.5	199
Long Term	69.3	253

about 4,000 cfs - nearly all of the summer streamflow in the lower Deschutes.

Local discharge from groundwater plays an important role in the basin. See Gannett and others (2001) for information about stream reaches with significant local groundwater discharge. Of interest here is assigning the impact of a mitigation project or a groundwater withdrawal to discharge along an appropriate stream reach. Does the project or groundwater withdrawal affect discharge to a local stream reach or does it affect the regional discharge near Lake Billy Chinook?

The OWRD defines seven 'zones of impact' to describe watersheds that include and are above areas (i.e., stream reaches) of significant groundwater discharge to surface water. To define boundaries for the local zones of impact, the OWRD considered sub-basin boundaries, locations where in-stream water rights or scenic waterway flows are not being met, general ground water flow information, and other hydrogeologic information, including identification of stream reaches influenced by groundwater discharge. By defining the boundaries for each of the local zones of impact, mitigation may be targeted to areas where mitigation projects may provide the greatest in-stream benefits (Kenneth L. Lite, written Communication, 2008).

One of the zones of impact is the regional or general zone of impact near Billy Chinook (Figure 2). The other six local zones are: 1) the Crooked River above river mile 13.8, 2) the Metolius River above river mile 28, 3) the Middle Deschutes River above river mile 125, 4) Whychus Creek above river mile 16, 5) the Upper Deschutes River above river mile 185, excluding the Little Deschutes, and 6) the Little Deschutes River above the mouth (Figures 3 to 8, respectively). See Table 6 for the watersheds associated with each zone of impact.

Also shown on Figures 2 to 8 are the locations where changes in streamflow are analyzed and the locations of the affected in-stream flow requirements. Note that some zones of impact have more than one analysis location. Conversely, the Whychus Creek and the Crooked River zones of impact are not represented at all, as there is not a suitable gaging station for either zone.

Table 6. The zones of impact and their associated watersheds.

Zone of Impact	Associated Watershed
General	30530643
Metolius River	70698
Crooked River	30630508
Middle Deschutes River	70695
Whychus Creek	70753
Upper Deschutes River	30530138
Little Deschutes River	70757

For the Whychus Creek zone, the one long-term gage, Whychus Creek near Sisters, OR (14075000), is located above the expected impacts of mitigation or groundwater withdrawals. Although the major diversion from Whychus Creek (the Three Creek Irrigation District Canal) is gaged and could be used to 'correct' the record for the gage, another 20 cfs or so of diversion is unaccounted for. For the Crooked River zone, a gaging station is located at an appropriate location (just below Osborne Canyon), but its period of record does not coincide with the selected base period, 1966 to 1995.

The zone of impact determination is discussed in a later section.

Description of the Mathematical Model

The model mathematically estimates the impacts on streamflow of the various mitigation projects and groundwater allocations permitted under the Deschutes Groundwater Mitigation Rules. It then determines if these impacts change the frequency with which in-stream flow requirements in the basin are met.

The estimated streamflow impacts are independent of the actual streamflow, that is, they represent the *change* in streamflow. Because actual streamflows are not required, these impacts can be estimated and accumulated at any location in the basin, but as a practical matter, only 50 locations were selected for this purpose (Table 1). These locations were selected based on the location of in-stream demands and on the physiography of affected streams. Generally they are above the mouths of significant tributaries, on main channels above significant tributaries and for all in-stream demands.

The streamflow impacts are all based on the consumptive uses associated with the mitigation project or groundwater allocation. The consumptive uses generally are determined following the methodology described by Cooper (2002) for the OWRD's Water Availability Program. How these consumptive uses are used in estimating streamflow impacts is discussed in detail in the following two sections and in Appendices A and B.

The effect of the streamflow impacts on the percent of time in-stream flow requirements are met may be evaluated only where actual measured streamflows are available. There are eight suitable locations in the Deschutes Basin. Each of these analysis locations is associated with a continuous record of streamflows and a location where streamflow impacts are accumulated (Table 2).

The percent of time in-stream flow requirements are met is determined by comparing the historic streamflow to the in-stream flow requirement. The existing or baseline condition is based on the actual streamflow record. The impacted condition is based on the actual streamflow record modified by the accumulated streamflow impacts. Whether an in-stream requirement is met is determined on a daily basis (using *mean* daily flows as the basis for comparison) and is reported as the percent of days the in-stream flow requirements are met both monthly and annually.

Water years 1966 to 1995 were chosen to represent the baseline condition. This time period is after completion of all reservoirs and prior to any ground water withdrawals subject to regulation under the State Scenic Waterway Act. The historic streamflows are adjusted for effects of new groundwater uses and mitigation activities *as though* the uses and mitigation

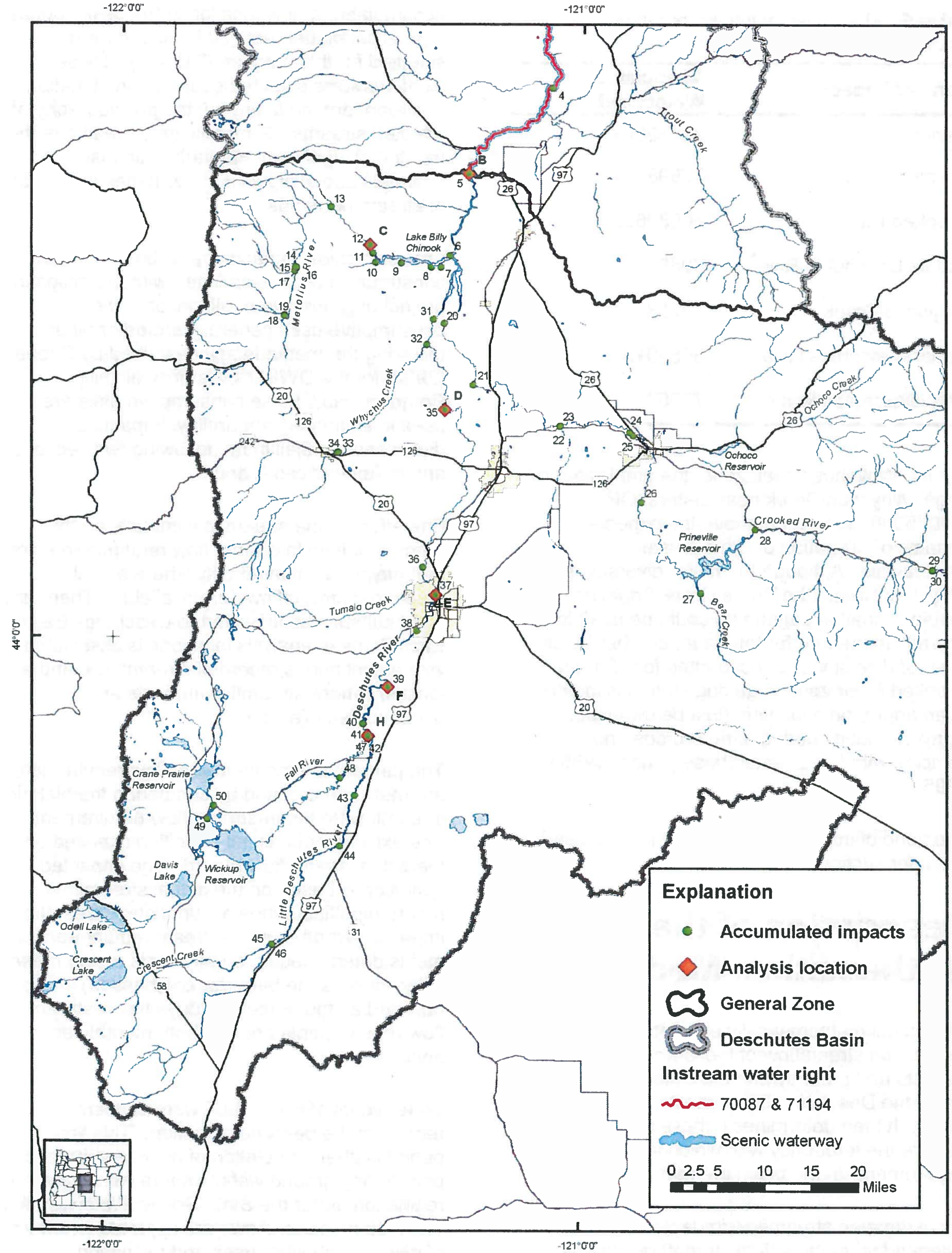


Figure 2. General zone of impact. See Table 1 for a map key to accumulated impacts and Table 2 for a map key to the analysis locations.

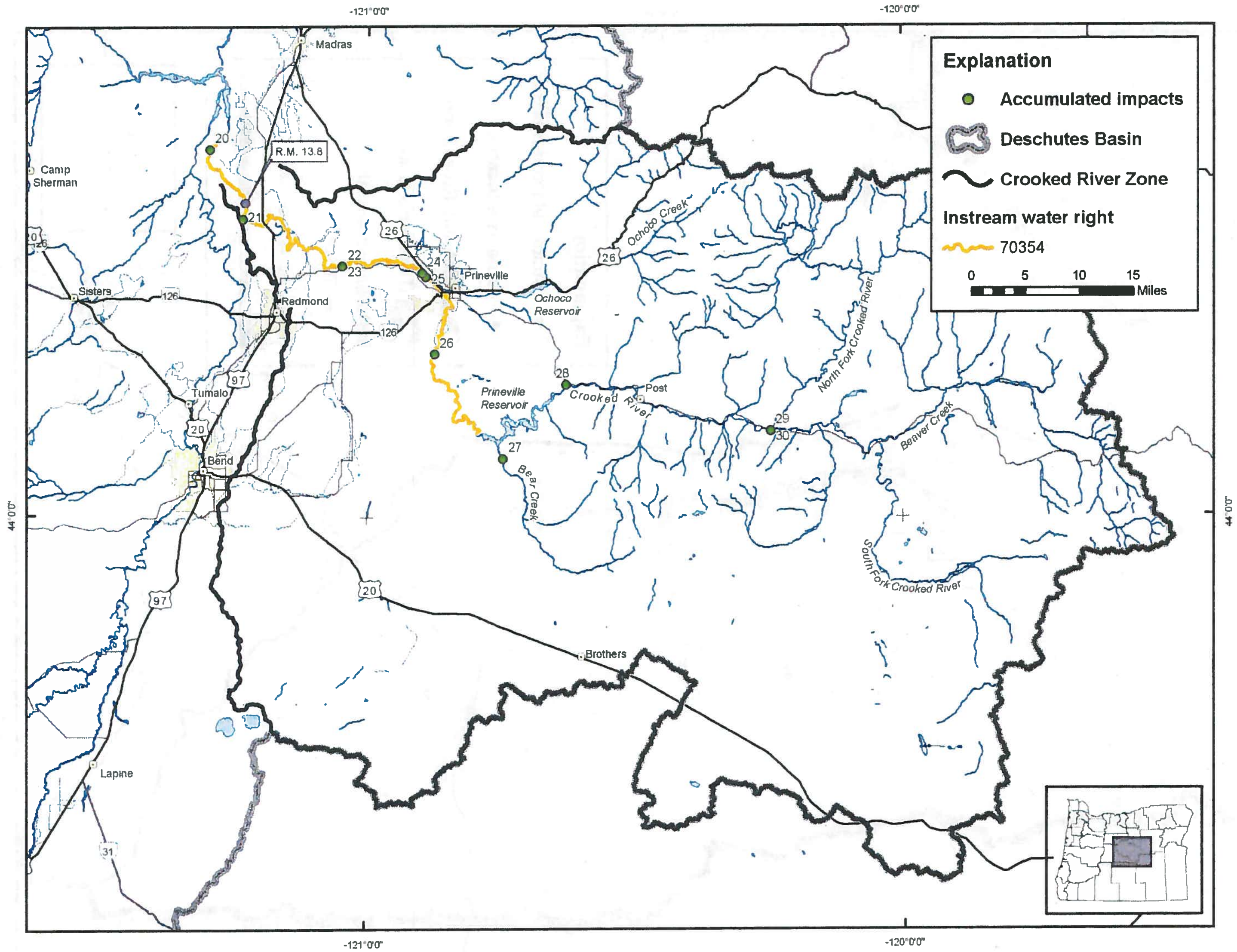


Figure 3. Crooked River zone of impact. See Table 1 for a map key to accumulated impacts and Table 2 for a map key to the analysis locations.

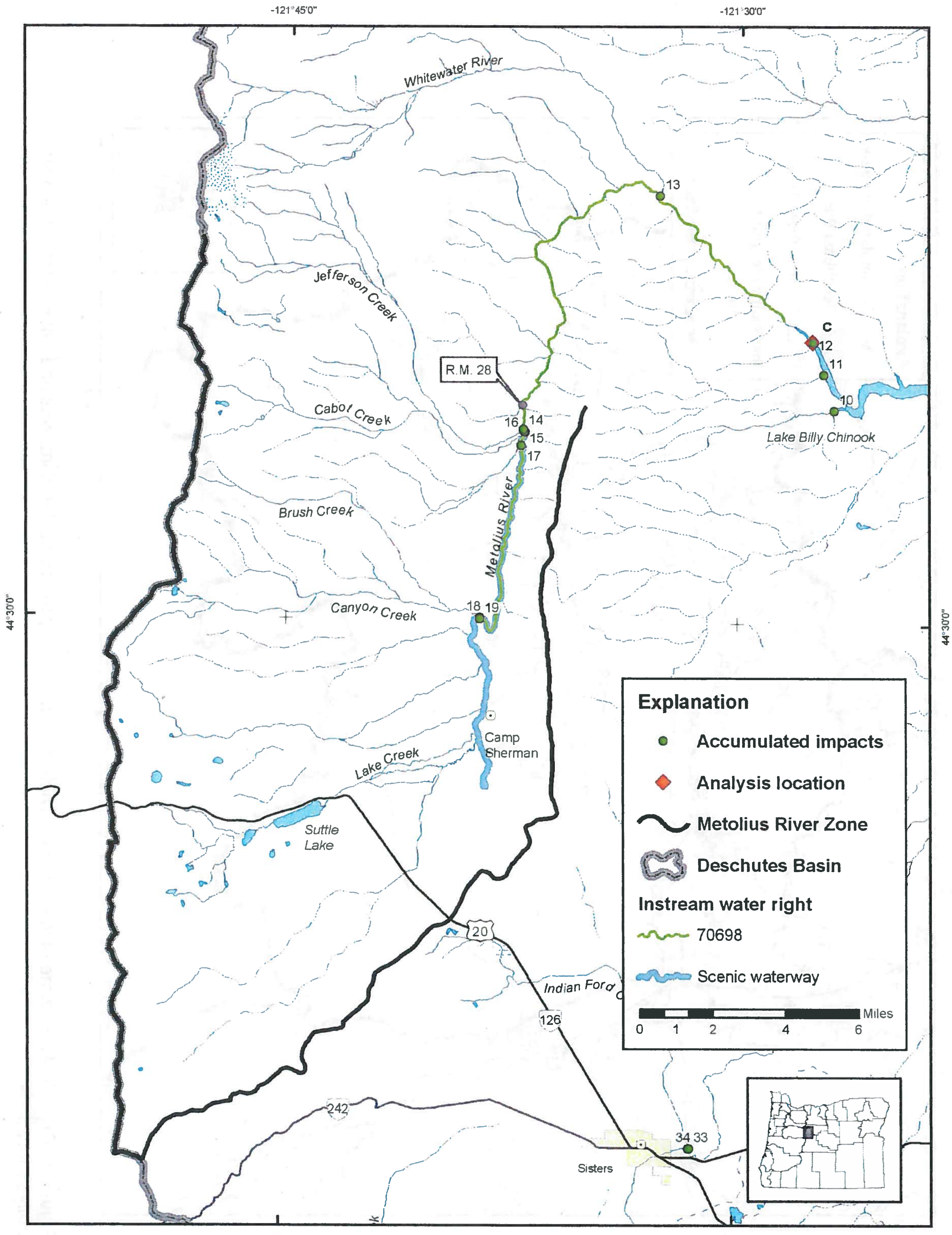


Figure 4. Metolius River zone of impact. See Table 1 for a map key for accumulated impacts and Table 2 for a map key to the analysis locations.

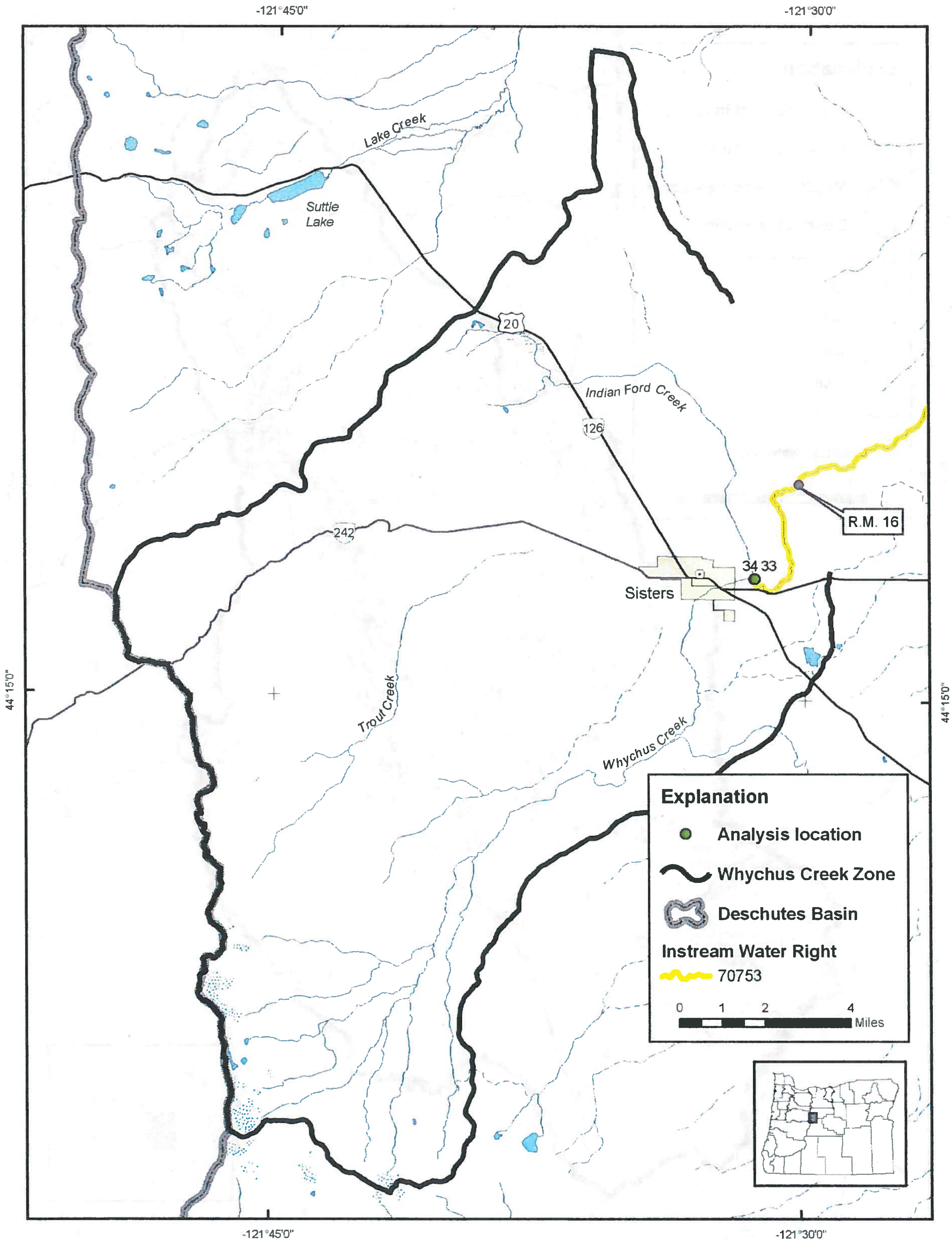


Figure 5. Whychus Creek zone of impact. See Table 1 for a map key for accumulated impacts and Table 2 for a map key to the analysis locations.

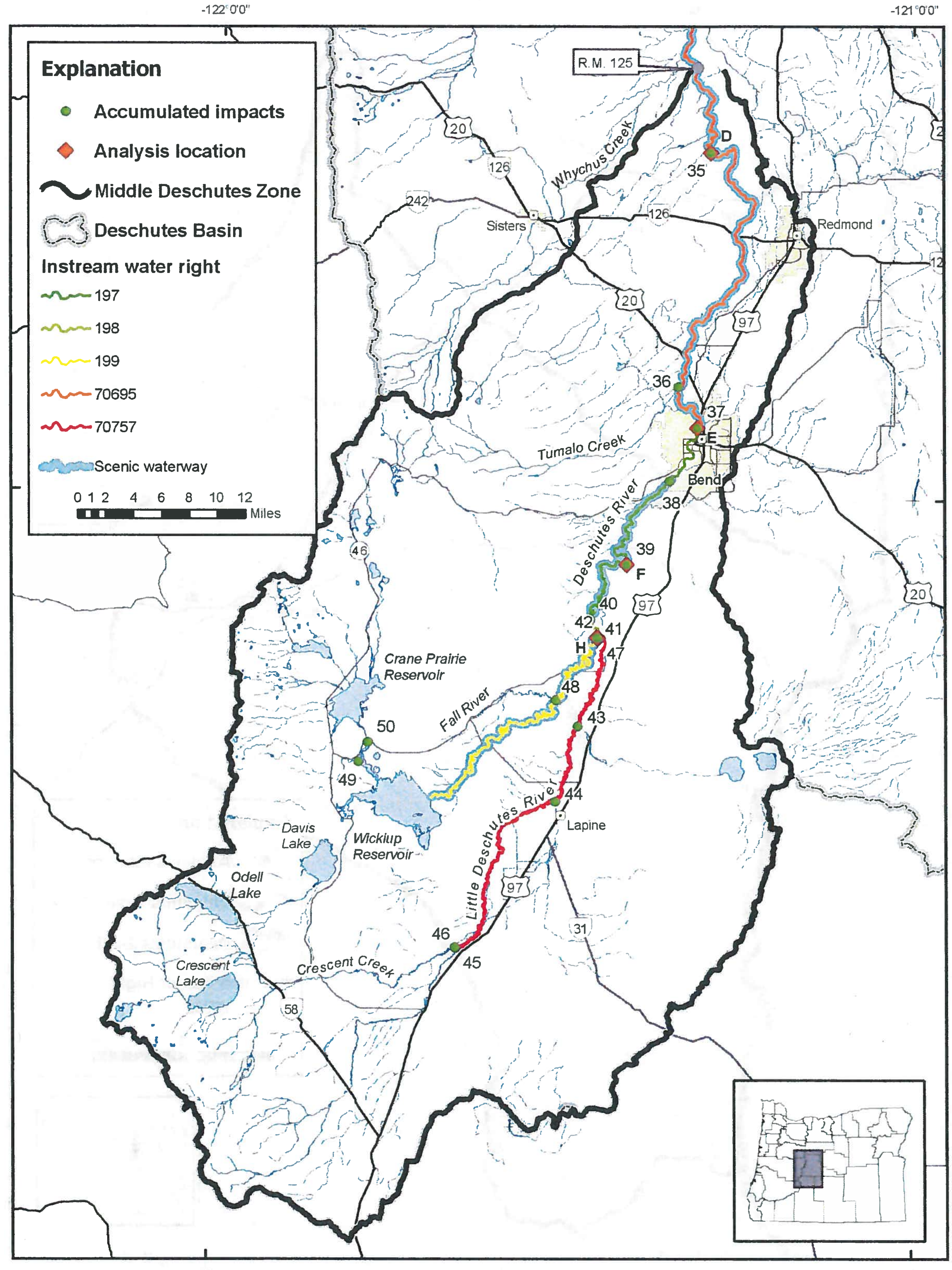


Figure 6. Middle Deschutes River zone of impact. See Table 1 for a map key for accumulated impacts and Table 2 for a map key to the analysis locations.

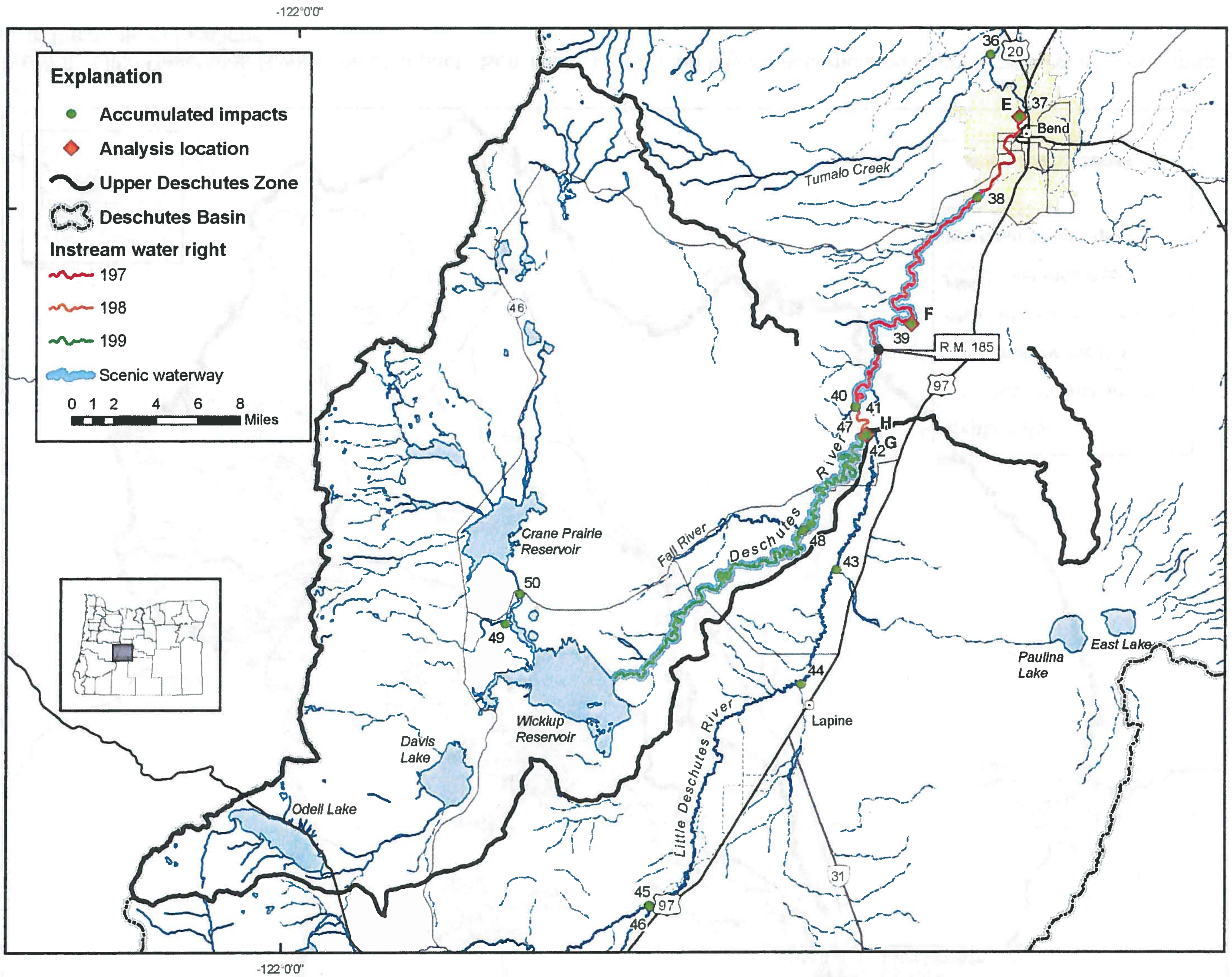


Figure 7. Upper Deschutes River zone of impact. See Table 1 for a map key for accumulated impacts and Table 2 for a map key to the analysis locations.

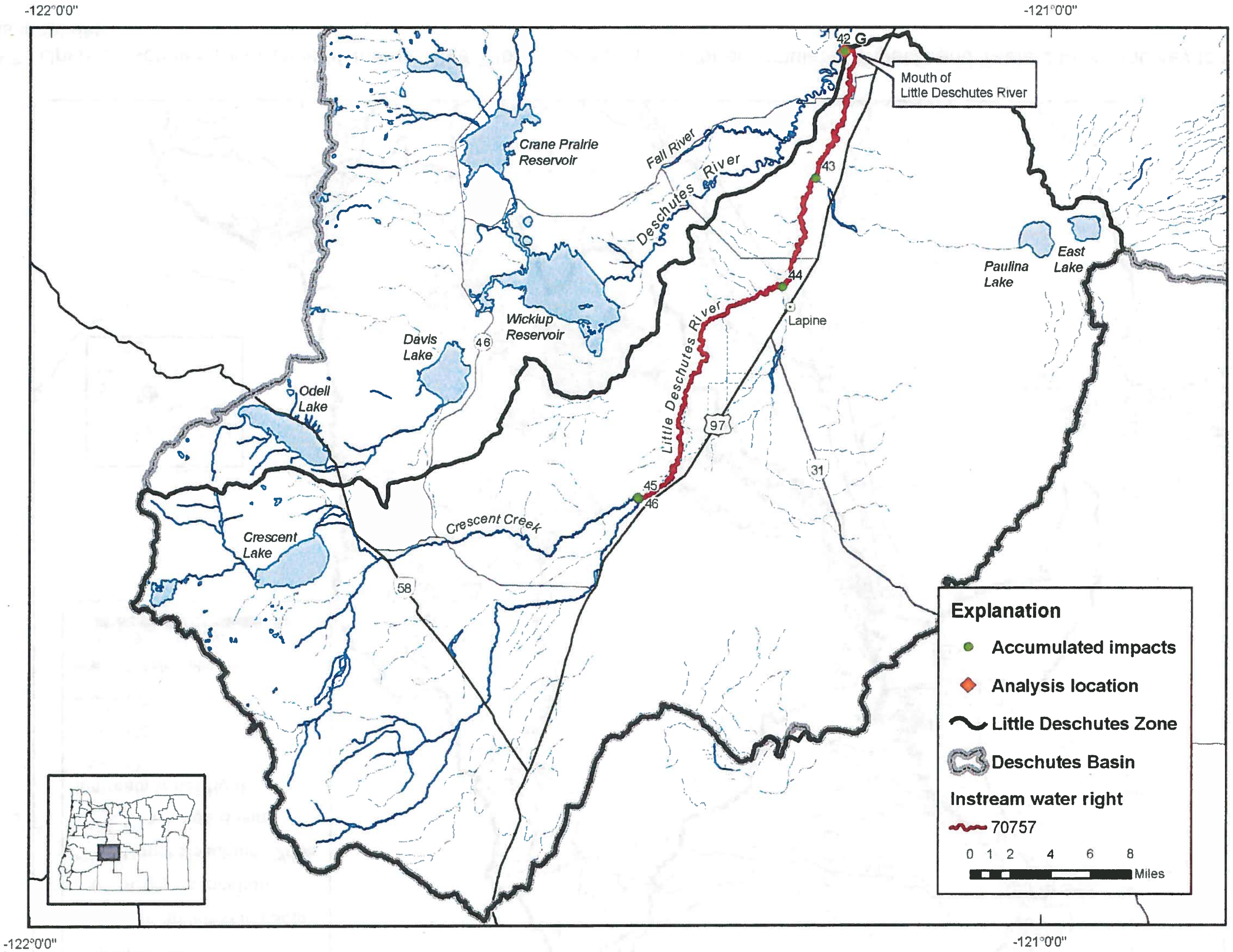


Figure 8. Little Deschutes River zone of impact. See Table 1 for a map key for accumulated impacts and Table 2 for a map key to the analysis locations.

activities were in place, fully developed and fully realized throughout the period of record.

The effects of groundwater withdrawals and mitigation activities are measured by the change in the percentage of time the mean daily flows exceed in-streamflow requirements, monthly and annually. As an example, Tables 5 and 7 show the baseline condition for the amount of time the scenic waterway flows are met in the Deschutes River below Pelton Dam. Examples showing the impacts of a mitigation project and of a groundwater withdrawal on streamflow are given in Appendices A and B, respectively.

Mitigation

Mitigation activities are expected to "offset" the effects of new allocations of groundwater on surface water. In practice, groundwater use will be linked to specific mitigation projects. For this model, however, mitigation projects and groundwater use are considered as independent of one another with mitigation projects generating credits and groundwater use generating debits.

Four types of mitigation projects are identified under the mitigation rules: 1) in-stream leases and transfers, 2) allocation of conserved water, 3) aquifer storage and recovery, and 4) allocation of existing stored water to in-stream use. These mitigation projects use existing methods to create water rights; the methods were not developed as part of the mitigation program. All of these methods have specific requirements defined in statute and rule and must result in a quantity of water that is legally protected in-stream. To date, only in-stream leases and transfers have been used to establish mitigation credits.

Volumetrically, leases and transfers of existing water rights to in-stream provide 'drop for drop' mitigation. A transfer puts the same volume of water in-stream as is allowed to be removed from streamflow by associated groundwater withdrawals. Overall, consumptive use in the basin remains the same. A lease, however, puts twice the water in-stream as is allowed to be removed by associated groundwater withdrawals. Overall, consumptive use in the basin is reduced.

The other three types of mitigation projects decrease streamflow by increasing consumptive use overall in the basin. In these cases, new consumptive uses of water are allowed without the compensating retirement of an existing water right. Note, however, that a decrease in streamflow does not necessarily mean a decrease in the frequency an in-stream flow requirement is met. If the new allocations impact streamflow at times when sufficient water is present to meet the in-stream demands, the frequency will not be diminished.

Mitigation projects affect streamflow both above and below an area of groundwater discharge or zone of impact. All four cases of mitigation projects either modify existing diversions from surface flow or create new diversions. These additions to or subtractions from streamflow affect all stream reaches downstream whether above or below the area of discharge.

Table 7. Percent of days the in-stream flow requirement is met by month in the Deschutes River below Pelton Dam (Gaging Station 14092500) for the period, water years 1966 to 1995.

Month	Percent of days for each month for all years	Average number of days per month for all years
1	64.7	20
2	63.0	18
3	67.8	21
4	71.4	21
5	58.8	18
6	55.6	17
7	41.0	13
8	98.2	30
9	66.8	20
10	81.1	25
11	97.2	29
12	66.1	21
Annual	69.3	253

All of the mitigation projects except allocation of existing stored water also affect groundwater discharge. These effects are realized only downstream of the affected zones of impact.

The first type of mitigation project, in-stream leases and transfers, is discussed in detail in Appendix A. Both the conceptual model and the mathematical model are discussed. An example calculation is also described.

For the other three types of mitigation projects, further discussion is not possible at this time. As this report is being written, the ways in which these types of mitigation might be implemented have not been fully determined. When the exact terms are known in each case, an addendum to this report will be written describing the implementation of the mitigation project along with an example calculation to illustrate the streamflow impacts.

Groundwater Withdrawals

The impacts of groundwater withdrawals are simply accounted for in the model. The consumptive part of the withdrawal is debited from streamflow downstream from the zone of impact. Two simplifying assumptions are made regarding this accounting: 1) impacts are distributed uniformly over the year and 2) impacts are realized only downstream of the zone of impact.

First, although the withdrawals, and hence the consumptive use, likely vary seasonally, we assume the temporal variation is completely attenuated by passage through the affected groundwater system. In the model, then, the impacts are uniformly distributed over the year. This assumption is consistent with the observed behavior of the regional ground-water flow system in the Deschutes Basin (Gannett and others, 2001).

Second, for a groundwater withdrawal, the pressure response that may propagate up gradient with possible upstream effects is ignored, and it is assumed that all impacts on groundwater discharge to streamflow are downstream of the zone of impact. Gannett and Lite (2004) show that upstream effects are generally small compared to downstream effects.

Groundwater withdrawals are discussed in detail in Appendix B. Both the conceptual model and the mathematical model are discussed. An example calculation is also provided.

Zone of Impact Determination

A zone of impact determination is required wherever a groundwater withdrawal or a mitigation project impacts either a local or the regional groundwater system. A groundwater withdrawal always requires a zone of impact determination. A mitigation project may or may not require a determination. For example, a determination is required for mitigation projects involving aquifer storage, but not for those involving allocation of existing stored water.

For mitigation projects involving leases, transfers and allocation of conserved water, a zone of impact determination is required in most cases, but not all. Usually, a water use is not entirely consumptive, and some of the originally diverted water is returned to streamflow, most often by way of groundwater (See Cooper, 2002, for further discussion). Where there are return flows, and they are by way of groundwater, a zone of impact determination is required.

In a few cases, the water use may be entirely consumptive with no return flows, or if not entirely consumptive, the return flows are by means other than groundwater (e.g., a sewage outfall discharging directly to surface water). In these cases, groundwater is unaffected, and a zone of impact determination is not required.

To date, all mitigation projects have been for an in-stream lease or transfer of a water right originally allocated for irrigation. All have required a zone of impact determination.

Where required, the determination of the correct zone of impact is made by a separate hydrologic analysis conducted by OWRD staff. Based on this determination, the mitigation model assigns the impact to the correct zone. For some mitigation projects, more than one zone of impact may be affected. In these cases, the effects are distributed among the affected zones of impact. Groundwater withdrawals are assumed to affect only one zone of impact. The determination of the zone of impact for a mitigation project is described in Appendix C, and the determination of the zone of impact for a groundwater withdrawal is described in Appendix D.

Groundwater Rights with the 7J Condition

Between 1995 and 2000, 193 groundwater rights were issued with a condition allowing regulation if the use was found to cause a measurable reduction in streamflow. This condition is commonly referred to as the 7J condition. Measurable reduction is defined by the Scenic Waterway Act as a reduction in streamflows within the scenic waterway in excess of one percent of the average daily flows or one cubic foot per second, whichever is less. In the Deschutes Basin, the threshold is one cubic foot per second in all cases.

Hydrologic studies conducted over the past century, including those of Russell (1905), Stearns (1932), Sceva (1960, 1968), and Gannett and others (2001), provide a preponderance of evidence to support a finding that groundwater use could cause a measurable reduction in scenic waterway flows. Water rights with the 7J condition are now subject to possible regulation. However, pursuant to the new Deschutes Ground Water Mitigation rules, these ground water right holders have the option of providing mitigation to avoid future regulation.

Water rights with the 7J condition are not accounted for in the model as they are subject to regulation. If the permit holders obtain mitigation credits to offset their water use, the rights will not be subject to regulation. If mitigation is acquired for any of these rights, the associated water use impacts and the new mitigation will be entered into the accounting.

Assumptions of the Model

This section summarizes the assumptions made related to model development and implementation.

The first of these assumptions concerns groundwater recharge and discharge. In the model, water is added to the regional or to a local groundwater system by way of return flows. Water is subtracted by way of groundwater withdrawals. In either case, the effects on streamflow of these additions or subtractions occur at the zone of impact associated with the groundwater system. Although the additions and subtractions may vary seasonally, the model assumes that any seasonality is completely attenuated by passage through the groundwater system, that is, the effects on discharge at the zone of impact are distributed uniformly in time. It is also assumed that groundwater withdrawals impact discharge to streamflow only downstream of the zone of impact.

We make two assumptions about the impact of Lakes Billy Chinook and Simtustus on flows in the lower Deschutes River. First, we assume that mitigation projects do not impact the operation of Round Butte and Pelton Dams. Changes in streamflow upstream of Billy Chinook are passed through to the Deschutes River below Pelton Dam. Second, we assume future changes in operation of the Round Butte and Pelton Dams are independent of any changes in streamflow due to mitigation projects.

Finally, we assume steady state conditions, that mitigation projects and groundwater withdrawals are fully developed and that their effects downstream are fully realized. Please note that only permitted groundwater withdrawals backed by valid credits are included in the model. Although a municipal water right that is allowed incremental development may be permitted in total, each increment is included in the model only as credits are acquired to back it.

Other assumptions are made that are specific to the type of mitigation involved. For leases and transfers, these additional assumptions are given in Appendix A. Assumptions specific to the other types of mitigation projects will be discussed when the addendums to this report are written that describe the other types of mitigation projects.

Shortcomings of the Model

The model has at least three shortcomings.

First, the model does not account for streamflow travel times and attenuation[4] of peak flows. This shortcoming would affect streamflows from water leased or transferred in-stream if the releases were variable, e.g., proportional to existing streamflow. However, in-stream transfers are constant over long periods. For example, an in-stream transfer might be set for 3 cfs from April to June, 5 cfs from July to August and 2 cfs in September and October. When streamflows remain constant, the effects of travel time and attenuation are small.

Second, the model does not account for storage effects due to Lakes Billy Chinook and Simtustus. The model assumes that changes in streamflow due to leases or transfers of water in-stream or due to new diversions for aquifer storage are simply passed through the lakes without affecting operation of the Round Butte and Pelton Dams.

This assumption does not claim that the reservoir has no effect on streamflows passing through it; the reservoir, in fact, *does* affect flows. These effects are accounted for in the streamflow record below the reservoir. The assumption only claims that streamflow changes due to mitigation projects upstream of the reservoir would not have caused a change in reservoir operation.

Apart from their operation, the reservoirs could attenuate changes in streamflow simply because they are a wide spot in the river. As already noted, however, in-stream releases due to leases and transfers will be constant for long periods and attenuation should not be a factor. On the other hand, diversions for aquifer storage are not likely to be uniform. The model will not account for smoothing of these decreases in streamflow.

Third, not every in-stream flow water requirement could be evaluated for impacts due to mitigation activities. Only those in-stream water right reaches with a gaging station in operation from 1966 to 1995 were candidates for evaluation.

[4] Due to in-channel and out-of-bank storage and friction losses, peak streamflows are reduced in magnitude (attenuated) as they travel downstream.

References

Cooper, RM. 2002. Determining Surface Water Availability in Oregon. Open File Report SW 02 – 002. Oregon Water Resources Department, Salem, Or. 57 p.

Gannett, M.W., Lite, K.E., Jr., Morgan, D.S., and Collins, C.A., 2001, Ground-water hydrology of the upper Deschutes Basin, Oregon: U.S. Geological Survey Water-Resources Investigations Report 00-4162, 78 p.

Gannett. M.W., and Lite, K.E., Jr., 2004, Simulation of regional ground-water flow in the upper Deschutes Basin, Oregon: U.S. Geological Survey Water-Resources Investigations Report 03-4195, 84 p.

Russell, I.C., 1905, Geology and water resources of central Oregon: U.S. Geological Survey Bulletin 252, 138 p.

Sceva, J.E., 1960, A brief description of the ground water resources of the Deschutes River Basin, Oregon: Oregon State Engineer [now Oregon Water Resources Department], Salem, Oregon, 55 p.

Sceva, J.E., 1968, Liquid waste disposal in the lava terrane of central Oregon: U.S. Department of the Interior, Federal Water Pollution Control Administration, Technical Projects Branch Report No. FR-4, 66 p. plus a 96 page appendix.

Stearns, H.T., 1931, Geology and water resources of the middle Deschutes River Basin, Oregon, U.S. Geological Survey Water-Supply Paper 637–D, 220

Appendix A - Leases and Transfers

In this case, a water right for an out of stream consumptive use is leased or transferred to an in-stream water right. The water assigned to in-stream use is legally protected from diversion by downstream users with junior priority dates. This increase in streamflow mitigates for streamflow lost to groundwater withdrawals.

By annual volume, the amount of water moved in-stream is equal to the allowed diversion for on-farm use (excludes transmission losses) under the old water right. The lease or transfer specifies the amount to be moved in-stream, the distribution of the in-stream flow requirements over the year, and the river reaches where the requirements are applied. Table A-1 gives an example of an in-stream lease. Note that the diversion (DV) is equal to the return flow (RF) plus the consumptive use (CU): DV = RF + CU. This lease is used later in an example calculation to show its impact on streamflow.

To compensate for transmission losses, many water uses in the Deschutes Basin divert significantly more than is required for on-farm use. These transmission losses may account for nearly half the diversion. When one of these uses is transferred or leased in-stream, the transmission losses are not included. As the use is retired, the water formerly diverted for transmission losses is left in-stream, but is not protected by an in-stream water right and is available for diversion by downstream users. Neither the fate of this water nor its impact on streamflow is considered in this analysis.

The lease or transfer specifies the amount of water to be protected in-stream and the river reaches to which it applies. When assigning values to the in-stream flow requirements for the various reaches, the reach containing the original point of diversion is always assigned an in-stream flow requirement equal to the original diversion less transmission losses. The reaches downstream may be assigned in-stream flow requirements equal to or less than that for the upper most reach, but never more than that. The amount of the in-stream flow requirement assigned to each reach depends on three factors: 1) the possibility of injury to downstream users, 2) the possibility of enlargement of the water right, and 3) the ability of the watermaster to measure the increased flow. However, for a given lease or transfer, no reach may be assigned an in-stream flow requirement greater than that of the reach directly upstream.

Where a reach is protected by an in-stream flow requirement, it is assumed that the transferred water right has a priority date senior to other users on the stream reach that might otherwise access the water. In the model, then, streamflow for a reach is always increased by at least the amount of the in-stream flow requirement assigned to that reach. As will be explained next, in some cases, streamflow may be increased by more than the in-stream flow requirement.

If the assigned in-stream flow requirements decrease from one reach to the next downstream, or if a reach does not have an in-stream flow requirement, any unprotected water is assumed available for diversion. For each affected reach, the model asks whether users are present to divert the water.

Where users are not present, the model increases streamflow for the downstream reach in an amount equal to the increase in streamflow for the upstream reach. This is the case even though the increase in streamflow is greater than that specified by the in-stream flow requirement for the downstream reach.

Where users are present, the model assumes that all available water is diverted. In this case, the increase in streamflow for the downstream reach is equal to its in-stream flow requirement. If the downstream reach has no in-stream flow requirement, the increase in streamflow is zero. Table A-2 gives examples showing the effect on streamflow of a change in in-stream flow requirement with and without the presence of users able to divert the unprotected water.

It is assumed that any groundwater affected by return flow from the original diversion eventually discharges to surface water at the specified zone of impact. Before the lease or transfer, the groundwater discharge included the return flow. After the lease or transfer, the diversion is no longer made, and the return flow is no longer part of the groundwater discharge, that is,

Table A-1. An example of an in-stream transfer showing the amount diverted annually, the consumptive use and the return flows associated with the original water right, the seasonal distribution of the in-stream flow requirements, and the stream reaches where the requirements are applied.

Irrigated Acres	Duty	Transmission Loss
100 acres	9.91 acre-feet per acre	45 percent

Component of Total Diversion	Annual Volume (acre-feet)	Comment
Volume of water transferred in-stream (DV)	545	Equal to the diversion of the original water right for on-farm use (excludes transmission losses).
Consumptive use associated with the original water right (CU)	169	Assumes a consumptive use of 1.69 acre-feet per acre.
Return flows associated with the original water right (RF)	376	Continuous rate: 0.52 cfs
Transmission Losses	446	Neither the fate of this water nor its impact on streamflow is considered in this analysis.

	Season	Maximum Rate (cfs/acre)	In-stream Flow Requirement (cfs)
Seasonal distribution of the in-stream flow requirements	Apr 1 to May 1	$1/80^{th}$	0.690
	May 1 to May 15	$1/60^{th}$	0.920
	May 15 to Sep 15	$1/32.4^{th}$	1.700
	Sep 15 to Oct 1	$1/60^{th}$	0.920
	Oct 1 to Nov 1	$1/80^{th}$	0.690

Stream reaches where the in-stream flow requirements are applied	**All reaches from the COID North Canal diversion to Lake Billy Chinook**	
	Watershed ID#	**Watershed Name**
	197	Deschutes River above Tumalo Creek
	30530112	Deschutes River above Buckhorn Canyon
	70695	Deschutes River above Lake Billy Chinook

Table A-2. Examples showing the effect on streamflow of a change in in-stream flow requirement with and without the presence of users able to divert the unprotected water.

In-stream Flow Requirement			Change in Streamflow	
Upstream Reach	Downstream Reach	Users?	Upstream Reach	Downstream Reach
cfs			cfs	
2.0	1.0	No	2.0	2.0
2.0	1.0	Yes	2.0	1.0
2.0	None	No	2.0	2.0
2.0	None	Yes	2.0	0.0

streamflow is decreased by the amount of the return flow. The actual net annual increase to streamflow below the zone of impact, then, is equal to the diversion minus the return flow, that is, the consumptive use of the original water right (recall that DV = RF + CU). Note that the water transferred in-stream varies seasonally and that the water associated with the return flows is distributed uniformly over the year. Table A-3 gives examples showing the effect on streamflow of the loss of return flow with and without an in-stream flow requirement and with and without the presence of users able to divert any unprotected water.

The conceptual model for leases and transfers is shown in Figures A-1 and A-2. Figure A-1 shows the case where the original diversion is from the Deschutes River and the zone of impact is also on the Deschutes River. Figure A-2 shows the case where the original diversion is from the Deschutes River but the zone of impact is on the Crooked River. For each of these cases, two further cases are considered: A) before the lease or transfer with the original diversion still in place, and B) after the lease or transfer with the original diversion replaced by in-stream flow requirements. Not shown is the case where the original diversion is from the Crooked River and the zone of impact is also on the Crooked River. This case is essentially the same as the case where the diversion and the zone of impact are both on the Deschutes River. Some mitigation projects have diversions that occur on the Deschutes River but the places of

Table A-3. Examples showing the effect on streamflow of the loss of return flow with and without an in-stream flow requirement and with and without the presence of users able to divert any unprotected water. The downstream reach is at the Zone of Impact.

Change in streamflow for the upstream reach cfs	In-stream flow requirement for the downstream reach cfs	Lost Return Flow cfs	Users?	Change in streamflow for the downstream reach cfs
2.0	2.0	1.3	No	0.7
2.0	2.0	1.3	Yes	0.7
2.0	1.0	1.3	No	0.7
2.0	1.0	1.3	Yes	-0.3
2.0	None	1.3	No	0.7
2.0	None	1.3	Yes	-1.3

use are such that multiple zones of impact are affected - sometimes involving both the Crooked and Deschutes Rivers. The example calculation to follow considers such a case. The numerical model, the model assumptions, and the required model inputs are given in Tables A-4, A-5, and A-6 respectively.

Table A-4. The numerical model for a transfer or lease.

Increase streamflow due to in-stream flow requirements:

For the reach at the point of diversion:

$\Delta SF_n = DV$

Then beginning at the next reach downstream, DO the following for each reach below that in downstream order:

```
if ISWR_{i+1} > ISWR_i then
  if USERS then
     ΔSF_i = ΔSF_i + ISWR_i
  else
     ΔSF_i = ΔSF_i + ISWR_{i+1}
  end if
else
  ΔSF_i = ΔSF_i + ISWR_i
end if
end do
```

where $ISWR_i$ = in-stream flow requirement for reach i
DV = diversion for the original water right
ΔSF_i = *change* in streamflow for reach i
i = the reach number
n = the number of reaches

Decrease streamflow due to loss of return flow:

For all reaches at and below the Zone of Impact, DO the following in downstream order:

```
If ISWR_i > 0 then
   ΔSF_i = ΔSF_i – RF
end if
end do
```

Table A-5. Model assumptions for a transfer or lease.

The groundwater–surface water system is at steady state - mitigation activities are fully developed and their effects downstream are fully realized.
Return flows directly recharge either the regional or a local groundwater system that discharges to one of the zones of impact.
The change in streamflow for a reach can be no more than the change in streamflow for the reach upstream.
Unprotected water is assumed to be entirely diverted when users are present. It is further assumed there are no return flows from these diversions.
Unprotected water is assumed to be passed downstream when users are not present even when there is not an ISWR to protect it or if there is an ISWR that does not protect it in full.
If no users and $ISWR_i = 0$ or $ISWR_{i+1} > ISWR_i$, then $\Delta SF_i = ISWR_{i+1}$
Mitigation activities do not impact the operation of Round Butte and Pelton Dams. Changes in streamflow upstream of Billy Chinook are passed through to the Deschutes River below Pelton Dam.
Future changes in operation of the Round Butte and Pelton Dams are independent of any changes in streamflow due to mitigation activities.

Table A-6. The required model input for a transfer or lease.

Location of the point of diversion of the original water right.

DV and CU, the original diversion and its associated consumptive use.

- RF = D – CU

The in-stream flow requirements: $ISWR_{LBC}, \ldots, ISWR_{ZOI}, \ldots, ISWR_{n-1}, ISWR_n$

- The ISWRs are distributed as specified by the enabling lease or transfer.
- $ISWR_i \geq ISWR_{i-1}$, there are no breaks in protection, though protection may end. On an annual basis, $ISWR_n = DV$.

For all reaches, whether or not there are users likely to pick up unprotected water.

The Zone(s) of Impact

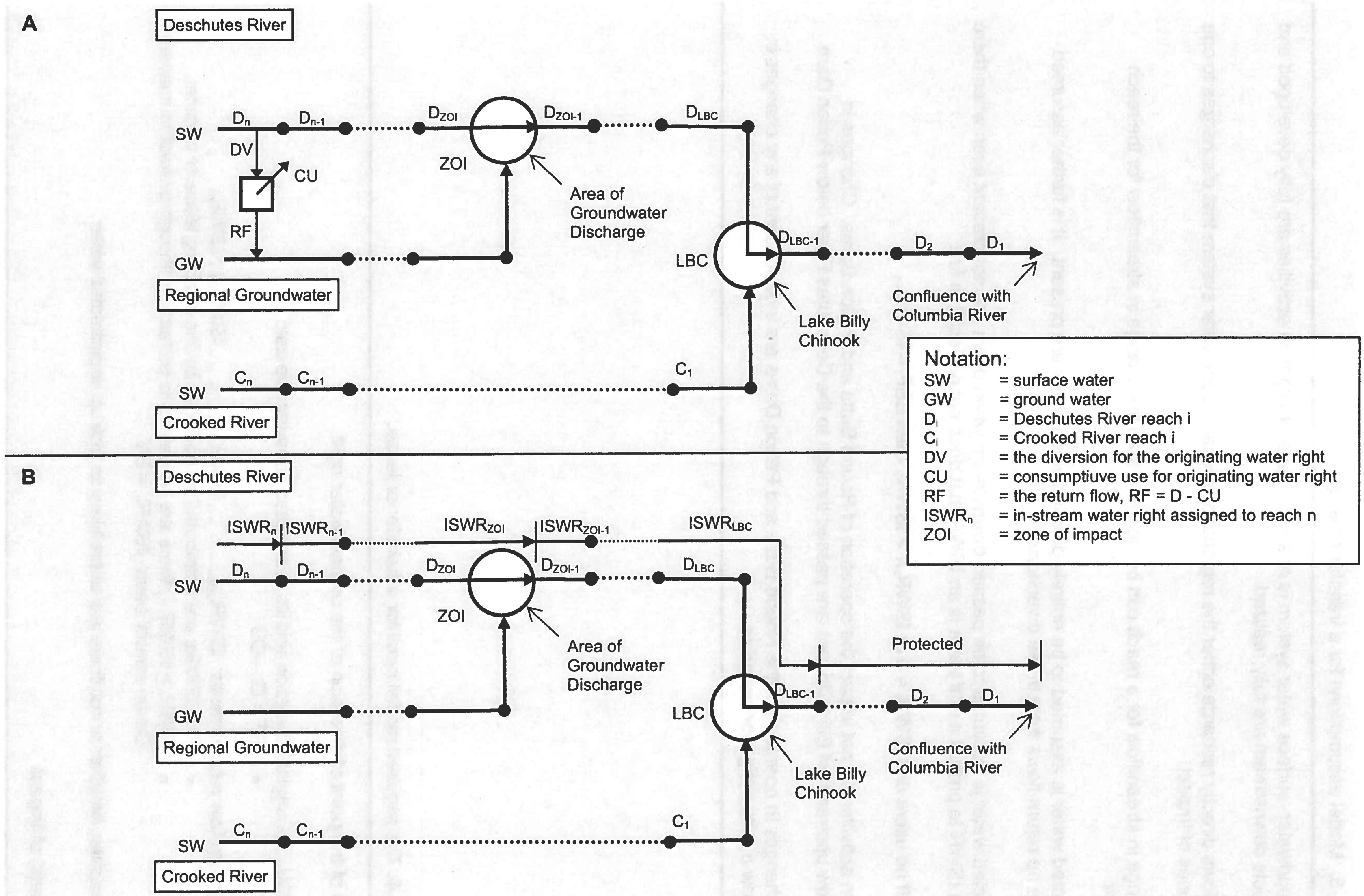


Figure A-1. Where the diversion and the zone of impact are both on the Deschutes River, showing the conceptual models for the cases (A) before and (B) after implementation of a lease or transfer.

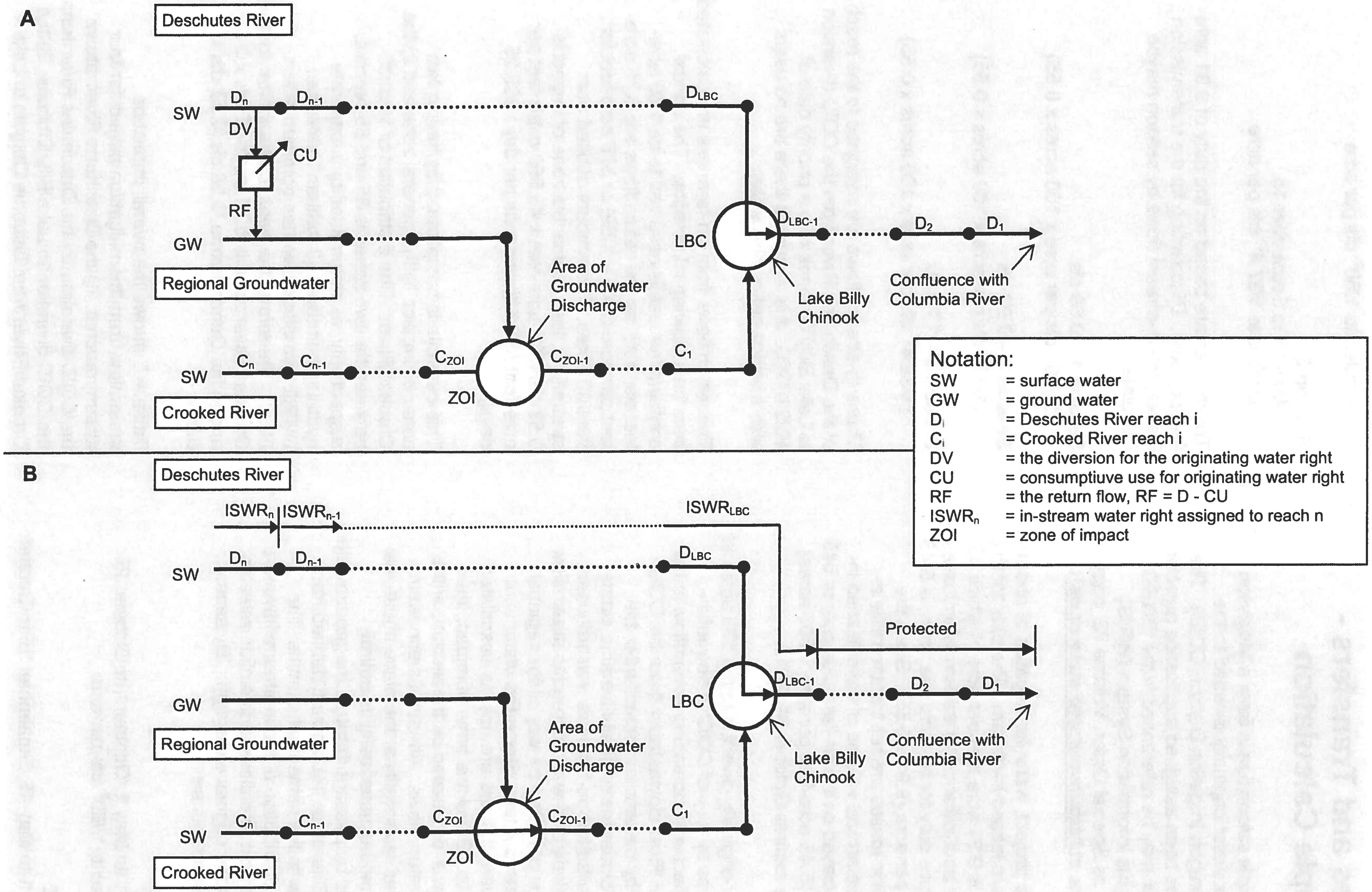


Figure A-2. Where the diversion is on the Deschutes River and the zone of impact is on the Crooked River, showing the conceptual models for the cases (A) before and (B) after implementation of a lease or transfer.

Leases and Transfers - Example Calculation

The example calculation is from a Mitigation Project for water originally diverted to the Central Oregon Irrigation District (COID). The project has been assigned application number IL-826, but may be referenced in the OWRD Water Rights Information System (WRIS) database as Special Order, Volume 72, page 282 (online at http://www.wrd.state.or.us/).

Under this project, water for irrigation of about 100 acres is leased in-stream. The duty for this diversion is 9.91 acre-feet per acre of which 45 percent is an allowance for transmission losses. The effective duty for on-farm use, then, is 5.45 acre-feet per acre (9.91 x 0.55). Since the transmission losses are not transferrable in-stream, the annual volume of water leased in-stream is based on the on-farm use only or 545 acre-feet (5.45 acre-feet per acre x 100 acres). The lease expires October 31, 2011.

The water originally diverted to the 100 acres for on-farm use by way of COID is now left in-stream effectively increasing streamflow in the Deschutes River downstream from the COID diversion by the amounts specified in the transfer. Under the original diversion, some water diverted for on-farm use was not used consumptively and was returned to streamflow at the zone of impact by way of the regional groundwater system. Since this water is no longer diverted, there are now no associated return flows. Below the zone of impact, then, streamflow is decreased by the amount of the previous return flows. Although these return flows varied seasonally at the place of use, we assume that the seasonality is entirely attenuated by passage through the groundwater system. Therefore, the amount debited from streamflow is the same in all months. The seasonal distribution of the in-stream flows are calculated from the allowed diversion rates as defined in the original water right. By season, the diversion rates are

Season 1
April 1 to May 1, October 1 to October 26
Limited to 1/80th cfs per acre

Season 2
May 1 to May 15, September 15 to October
Limited to 1/60th cfs per acre

Season 3
May 15 to September 15
Limited to 1/32.4th cfs per acre

These rates are based on the duty of 9.91 acre-feet per acre. Discounting for the transmission losses, the in-stream flows by season maybe calculated:

Season 1 – 0.69 cfs
(1/80th cfs per acre x 100 acres x 0.55)

Season 2 – 0.92 cfs
(1/60th cfs per acre x 100 acres x 0.55)

Season 3 – 1.70 cfs
(1/32.4th cfs per acre x 100 acres x 0.55)

These in-stream flows are assigned to the reach of the Deschutes River from the COID diversion to Lake Billy Chinook with a priority date of 10/31/1900. It is assumed there are no users with a senior call on this water.

The return flows from on-farm use are calculated from the following information. The annual consumptive use is assumed to be 1.69 acre-feet per acre, so the return flows are 3.76 acre-feet per acre (5.45 – 1.69) or 376 acre-feet for the 100 acres. The amount debited from streamflow, then, below the zone of impact is 0.52 cfs (376 acre-feet x 43,560 cubic feet per acre-foot / 86,400 seconds per day / 365.25 days).

This example is complicated by having two zones of impact: 1) the general zone and 2) the Crooked River. The distribution of 'impact' between the two zones is 35 and 65 percent, respectively, as determined by a separate hydrologic analysis (Jonathan LaMarche, OWRD hydrologist, written communication, 2008). Therefore, the debit to streamflow for the Crooked River zone is 0.34 cfs (0.52 cfs x 0.65) and to the General zone, 0.18 cfs (0.52 cfs x 0.35).

Table A-7 shows the overall impact on streamflow from the mitigation project for four stream reaches: 1) the Deschutes River above the COID diversion, 2) the Deschutes River from the COID diversion to Lake Billy Chinook, 3) the Crooked River from Osborne Canyon to Lake

Billy Chinook, and 4) the Deschutes River below Lake Billy Chinook. The table accounts for the distribution of impacts between the two zones.

The changes in streamflow are shown schematically in Figure A-3.

Table A-7. Estimated impact from a mitigation project on streamflow for four stream reaches in the Deschutes River Basin. The project transfers to in-stream, water for irrigation of about 100 acres. The water was originally diverted to the Central Oregon Irrigation District (COID). There are two zones of impact: 1) the General and 2) the Crooked River.

	River Reach			
Time Period	**Deschutes River** Headwaters to COID Diversion	**Deschutes River** COID Diversion to Lake Billy Chinook	**Crooked River** Osborne Canyon to Lake Billy Chinook	**Deschutes River** Lake Billy Chinook to mouth
	Estimated Change in Streamflow in cfs			
01/01 to 01/15	0.00	0.00	-0.34	-0.52
01/16 to 01/31	0.00	0.00	-0.34	-0.52
02/01 to 02/15	0.00	0.00	-0.34	-0.52
02/16 to 02/28	0.00	0.00	-0.34	-0.52
03/01 to 03/15	0.00	0.00	-0.34	-0.52
03/16 to 03/31	0.00	0.00	-0.34	-0.52
04/01 to 04/15	0.00	0.69	-0.34	0.17
04/16 to 04/30	0.00	0.69	-0.34	0.17
05/01 to 05/15	0.00	0.92	-0.34	0.40
05/16 to 05/31	0.00	1.70	-0.34	1.18
06/01 to 06/15	0.00	1.70	-0.34	1.18
06/16 to 06/30	0.00	1.70	-0.34	1.18
07/01 to 07/15	0.00	1.70	-0.34	1.18
07/16 to 07/31	0.00	1.70	-0.34	1.18
08/01 to 08/15	0.00	1.70	-0.34	1.18
08/16 to 08/31	0.00	1.70	-0.34	1.18
09/01 to 09/15	0.00	1.70	-0.34	1.18
09/16 to 09/30	0.00	0.92	-0.34	0.40
10/01 to 10/15	0.00	0.69	-0.34	0.17
10/16 to 10/31	0.00	0.69	-0.34	0.17
11/01 to 11/15	0.00	0.00	-0.34	-0.52
11/16 to 11/30	0.00	0.00	-0.34	-0.52
12/01 to 12/15	0.00	0.00	-0.34	-0.52
12/16 to 12/31	0.00	0.00	-0.34	-0.52

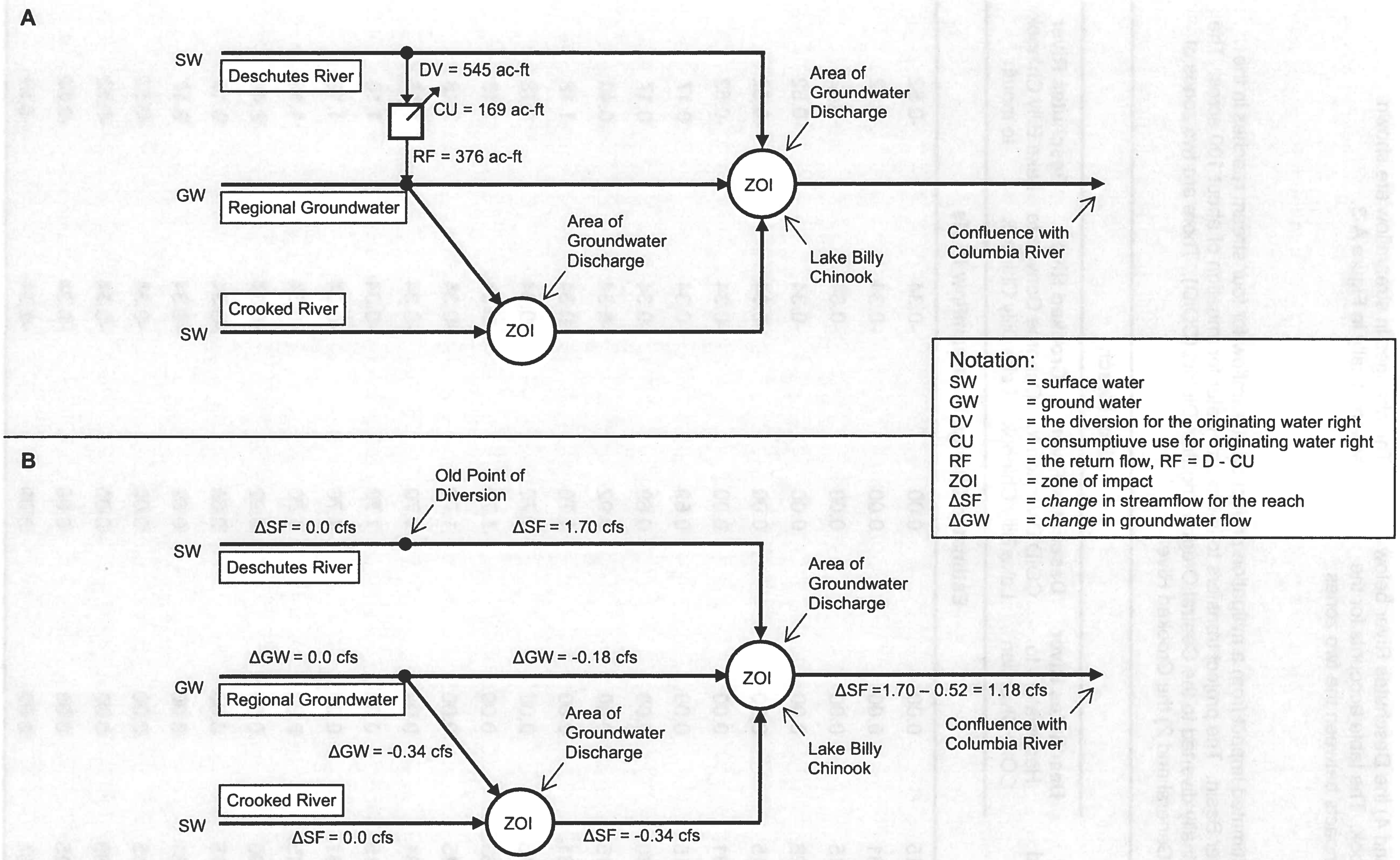


Figure A-3. A simplified schematic showing the change in streamflow for various reaches of the Deschutes and Crooked Rivers as a result of the in-stream lease given in the example. Case A shows the diversion prior to the lease. Case B shows the change in streamflow after the diversion is retired. Streamflow values are for July. See Table A-7.

Appendix B - Groundwater Withdrawals

All groundwater debits are treated the same in the model. The consumptive use is distributed uniformly over the year and subtracted from surface water flows downstream of the zone of impact. Upstream of the zone of impact, there is no effect on stream flow.

The conceptual model for groundwater withdrawals is shown in Figures B-1 and B-2. Figure B-1 shows the case where the zone of impact is on the Deschutes River. Figure B-2 shows the case where the zone of impact is on the Crooked River. For each of these cases, two further cases are considered: A) before the groundwater withdrawal and B) after the groundwater withdrawal has been implemented. It is assumed that a groundwater withdrawal affects only one zone of impact.

Only permitted groundwater withdrawals backed by valid credits are included in the analysis. Although a municipal water right that is allowed incremental development may be permitted in total, each increment is included in the model only as credits are acquired to back it.

The numerical model, the model assumptions, and the required model inputs are given in Tables B-1, B-2 and B-3, respectively.

Groundwater Withdrawal – Example Calculation

The example calculation is for a groundwater withdrawal for irrigation of 280 acres between Bend and Redmond near the Deschutes River. The water right has been assigned application number G15154 and may be referenced in the OWRD Water Rights Information System (WRIS) database (online at http://www.wrd.state.or.us/).

Consumptive use for this example groundwater withdrawal is 473 acre-feet per year. The amount debited from streamflow, then, below the zone of impact is 0.65 cfs (473 acre-feet x 43,560 cubic feet per acre-foot / 86,400 seconds per day / 365.25 days). The zone of impact is the General Zone (Ken Lite, OWRD hydrogeologist, written communication, 2008).

Table B-4 shows the impact on streamflow from the groundwater withdrawal for four stream reaches: 1) the Deschutes River above the COID diversion, 2) the Deschutes River from the COID diversion to Lake Billy Chinook, 3) the Crooked River from Osborne Canyon to Lake Billy Chinook, and 4) the Deschutes River below Lake Billy Chinook.

The changes in streamflow are shown schematically in Figure B-3.

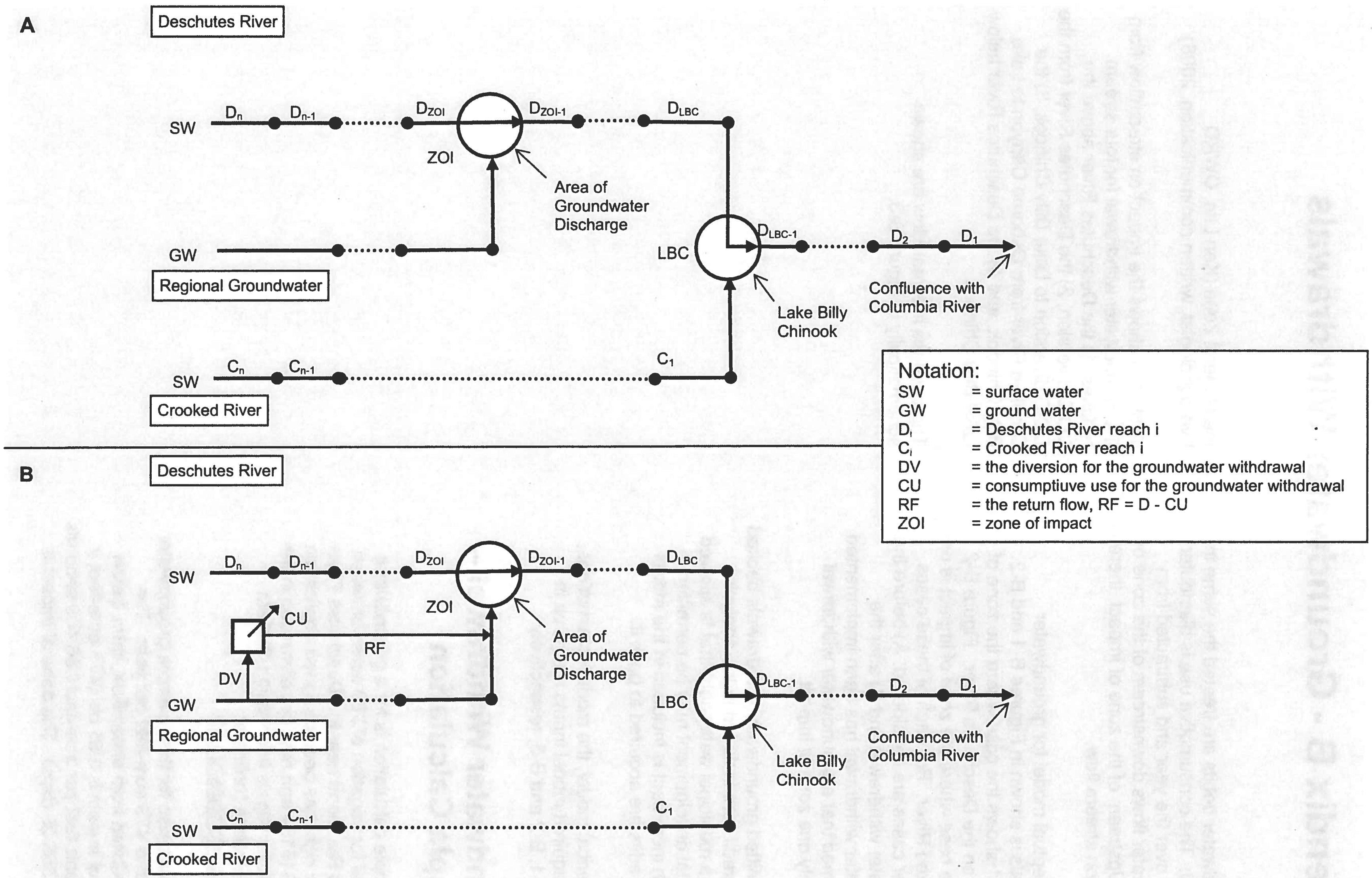


Figure B-1. Where the diversion and the zone of impact are both on the Deschutes River, showing the conceptual models for the cases before (A) and after (B) implementation of a groundwater withdrawal.

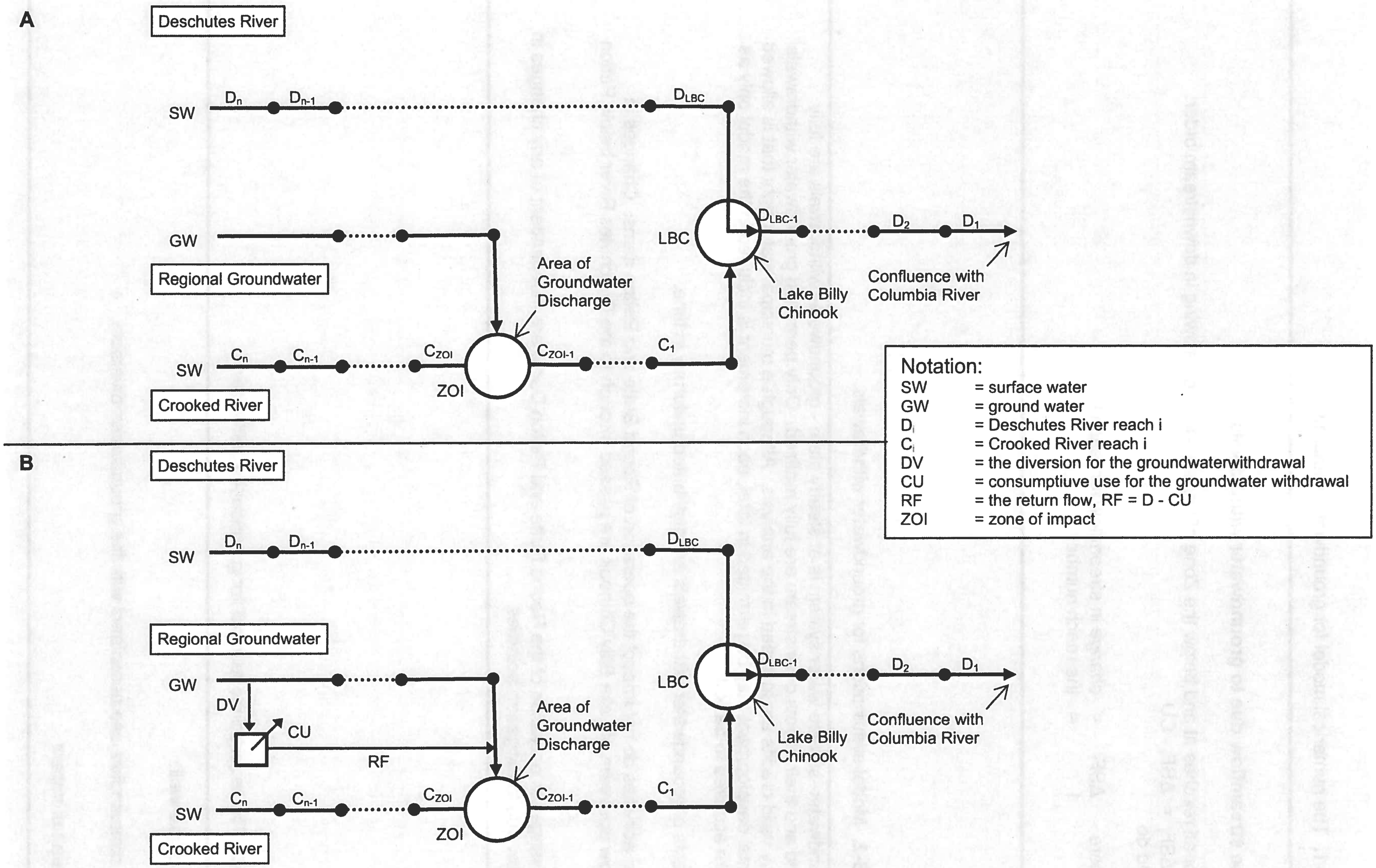


Figure B-2. Where the diversion is on the Deschutes River and the zone of impact is on the Crooked River, showing the conceptual models for the cases before (A) and after (B) implementation of a groundwater withdrawal.

Table B-1. The numerical model for groundwater withdrawals.

Decrease streamflow due to groundwater withdrawals:

For all reaches at and below the Zone of Impact, DO the following in downstream order:
$\Delta SF_i = \Delta SF_i - CU$
end do

where	ΔSF_i	=	*change* in streamflow for reach i
	i	=	the reach number

Table B-2. Model assumptions for groundwater withdrawals.

The groundwater–surface water system is at steady state - groundwater withdrawals are fully developed and their effects downstream are fully realized. Only permitted groundwater withdrawals backed by valid credits are included in the analysis. Although a municipal water right that is allowed incremental development may be permitted in total, each increment is included in the model only as credits are acquired to back it.

The impacts of groundwater withdrawals are distributed uniformly in time.

Mitigation activities do not impact the operation of Round Butte and Pelton dams. Changes in streamflow upstream of Lake Billy Chinook are passed through to the Deschutes River below Pelton dam.

Future changes in operation of the Round Butte and Pelton Dams are independent of any changes in streamflow due to mitigation activities.

Table B-3. The required model input for groundwater withdrawals.

Location of the well.

CU, the consumptive use associated with the groundwater diversion.

The Zone(s) of Impact

Table B-4. Estimated impact from a mitigated groundwater withdrawal on streamflow for four stream reaches in the Deschutes River Basin. This groundwater withdrawal is for irrigation of 280 acres between Bend and Redmond near the Deschutes River. Consumptive use is 473 acre-feet per year. The zone of impact is the General Zone.

Time Period	River Reach			
	Deschutes River – Headwaters to COID Diversion	**Deschutes River –** COID Diversion to Lake Billy Chinook	**Crooked River –** Osborne Canyon to Lake Billy Chinook	**Deschutes River –** Lake Billy Chinook to mouth
	Estimated Impact on Streamflow in cfs			
01/01 to 01/15	0.00	0.00	0.00	-0.65
01/16 to 01/31	0.00	0.00	0.00	-0.65
02/01 to 02/15	0.00	0.00	0.00	-0.65
02/16 to 02/28	0.00	0.00	0.00	-0.65
03/01 to 03/15	0.00	0.00	0.00	-0.65
03/16 to 03/31	0.00	0.00	0.00	-0.65
04/01 to 04/15	0.00	0.00	0.00	-0.65
04/16 to 04/30	0.00	0.00	0.00	-0.65
05/01 to 05/15	0.00	0.00	0.00	-0.65
05/16 to 05/31	0.00	0.00	0.00	-0.65
06/01 to 06/15	0.00	0.00	0.00	-0.65
06/16 to 06/30	0.00	0.00	0.00	-0.65
07/01 to 07/15	0.00	0.00	0.00	-0.65
07/16 to 07/31	0.00	0.00	0.00	-0.65
08/01 to 08/15	0.00	0.00	0.00	-0.65
08/16 to 08/31	0.00	0.00	0.00	-0.65
09/01 to 09/15	0.00	0.00	0.00	-0.65
09/16 to 09/30	0.00	0.00	0.00	-0.65
10/01 to 10/15	0.00	0.00	0.00	-0.65
10/16 to 10/31	0.00	0.00	0.00	-0.65
11/01 to 11/15	0.00	0.00	0.00	-0.65
11/16 to 11/30	0.00	0.00	0.00	-0.65
12/01 to 12/15	0.00	0.00	0.00	-0.65
12/16 to 12/31	0.00	0.00	0.00	-0.65

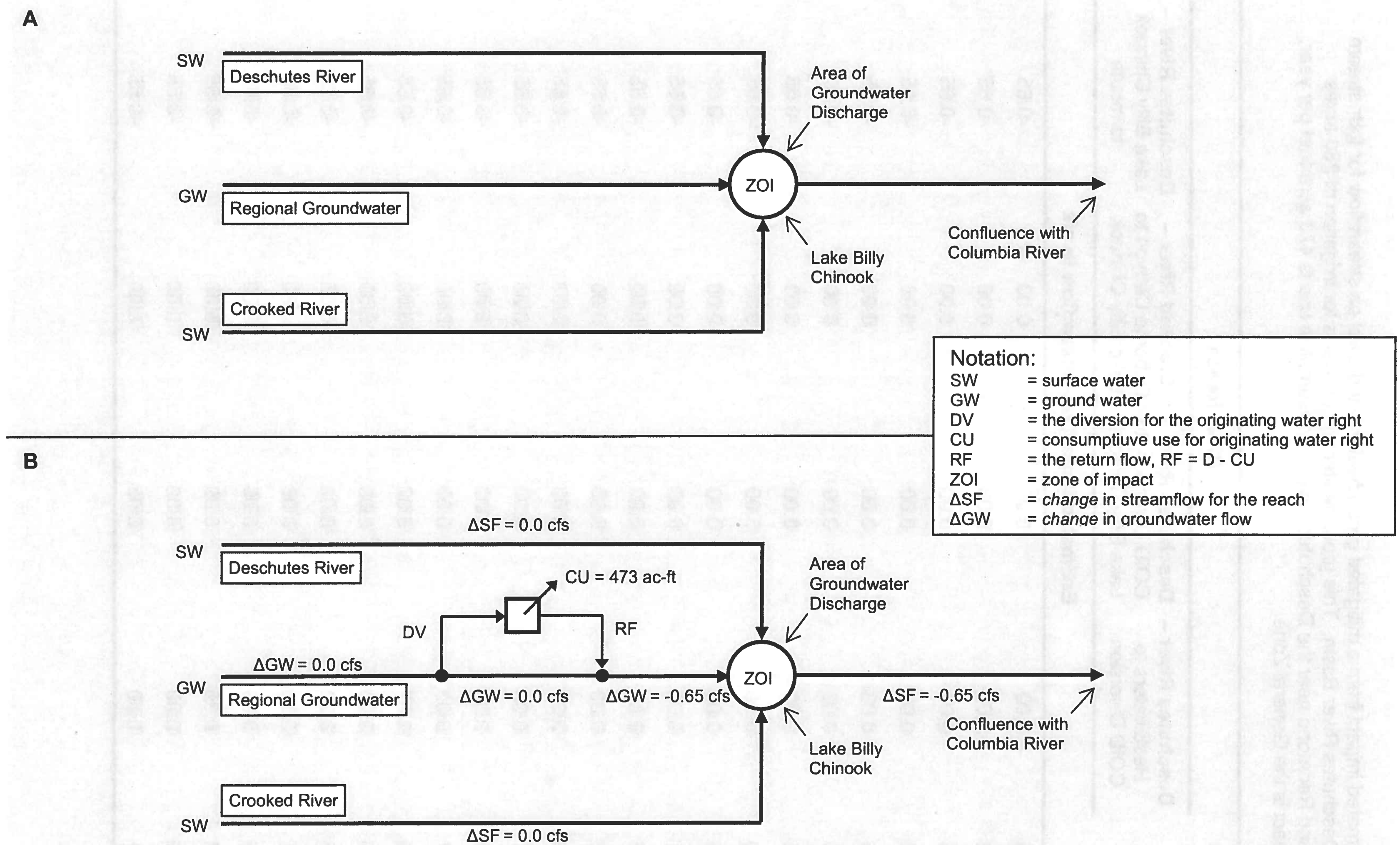


Figure B-3. A simplified schematic showing the change in streamflow for various reaches of the Deschutes and Crooked Rivers as a result of the groundwater withdrawal given in the example. Case A shows the situation prior to the withdrawal. Case B shows the change in streamflow after the withdrawal is implemented.

Appendix C - Zone of Impact Determination for a Mitigation Project

By Jonathan L. La Marche

A zone of impact determination is required whenever a mitigation project impacts groundwater. In all cases, the goal is to determine where water that has entered a local or the regional groundwater system, either through direct recharge or by way of return flows from a consumptive use, will be discharged to surface water. The determination is based on the following information:

1. Local shallow and regional groundwater elevations,

2. Shallow and regional groundwater head gradients (i.e., the groundwater flow direction),

3. Surface water elevations of nearby streams,

4. Surface water elevations of the closest gaining stream reaches,

5. Distances to nearby streams and gaining reaches along the local and regional flow paths, and

6. Local geologic information.

The analysis is done using Geographic Information System data taken from groundwater studies of the Deschutes basin (Gannett and others, 2001; Lite and Gannett, 2002; Gannett and Lite, 2004) and the location of the place of use (POU) as specified in the water right application. For many applications, multiple POUs are specified, and an evaluation is done for each. A mitigation project always impacts at least one zone of impact, but may impact multiple zones. Although not used in the mitigation model, the zone of impact affected by transmission losses is also determined as part of this evaluation.

An Example Evaluation

In this example, a water right is to be leased in-stream to generate mitigation credits. The water right is for irrigation of a parcel of land totaling 8.72 acres (township 15, range 13, and section 16, in the northwest of the southeast quarter-quarter). The irrigation water comes from the North Canal. The required analysis in this case is to determine which zone of impact is affected by return flows from on-farm losses associated with the irrigation.

The zone of impact was determined by first plotting the POU on a map of the local area (Figure C-1). Also plotted were the stream network and regional groundwater head gradients (from Gannett et. al. 2001, Lite and Gannett 2004). Relevant data were gathered from this map and other sources and are shown in Table C-1.

The data indicate that return flows most likely infiltrate (local vertical head gradient) and, given the distance between the POU and the nearest gaining reach (>8 miles), have a long flow path with ample opportunity for returns to enter the deeper regional system and discharge in the general zone. The nearby stream network is either above the regional groundwater water level (Cline Falls, < 4miles away) or shows no indication of groundwater inflows (Tethrow Crossing 4.5 miles away).

Table C-1. Information required for the determination of the zone of impact affected by a proposed mitigation project.

Description:

The place of use (POU) lies just south of Hwy 126 and just west of Hwy 97 within the city of Redmond. It comprises 8.72 acres. Irrigation water comes from the North canal.

Specific Information:

1. Local static water level and well depth elevation (from well GIS coverage):

a. shallow static water level	2860 ft msl	well depth	60 ft
b. deep static water level	2740 ft msl	well depth	360-800 ft

2. Head elevation at POU (USGS reports, Gannett and Lite, 2004; Gannett and others, 2001)
   a. Regional ~2700 ft msl
   b. Shallow ~2800 ft msl

3. Vertical head gradient present (Y or N)? Yes, ~100ft.

4. Regional groundwater Information:

a. Distance along regional groundwater flow path to stream	4.5 miles
b. Stream river mile and locale	RM 142, Tethrow Crossing
c. Elevation of stream at locale	2700 ft msl
d. Is this locale a gaining reach	No

5. Local groundwater information:

a. Distance from POU to nearest stream network	< 4 miles
b. Stream river mile and locale	RM 146, Cline Falls
c. Elevation of stream at locale	2840 ft msl
d. Is this locale a gaining reach	No

6. Does the POU lie in a paleo-drainage? No, but within a mile.

a. Distance along drainage to stream	~8 miles.
b. Stream river mile and locale	RM 137.5, below Odin Falls
c. Elevation of stream at confluence	2620 ft msl
d. Is this locale a gaining reach	yes (slight)

7. Does the POU lie on a unique geologic formation?
   Post Deschutes-age deposits in paleo-drainage surrounded by lava flows (Fig. 14 Lite and Gannett, 2002).

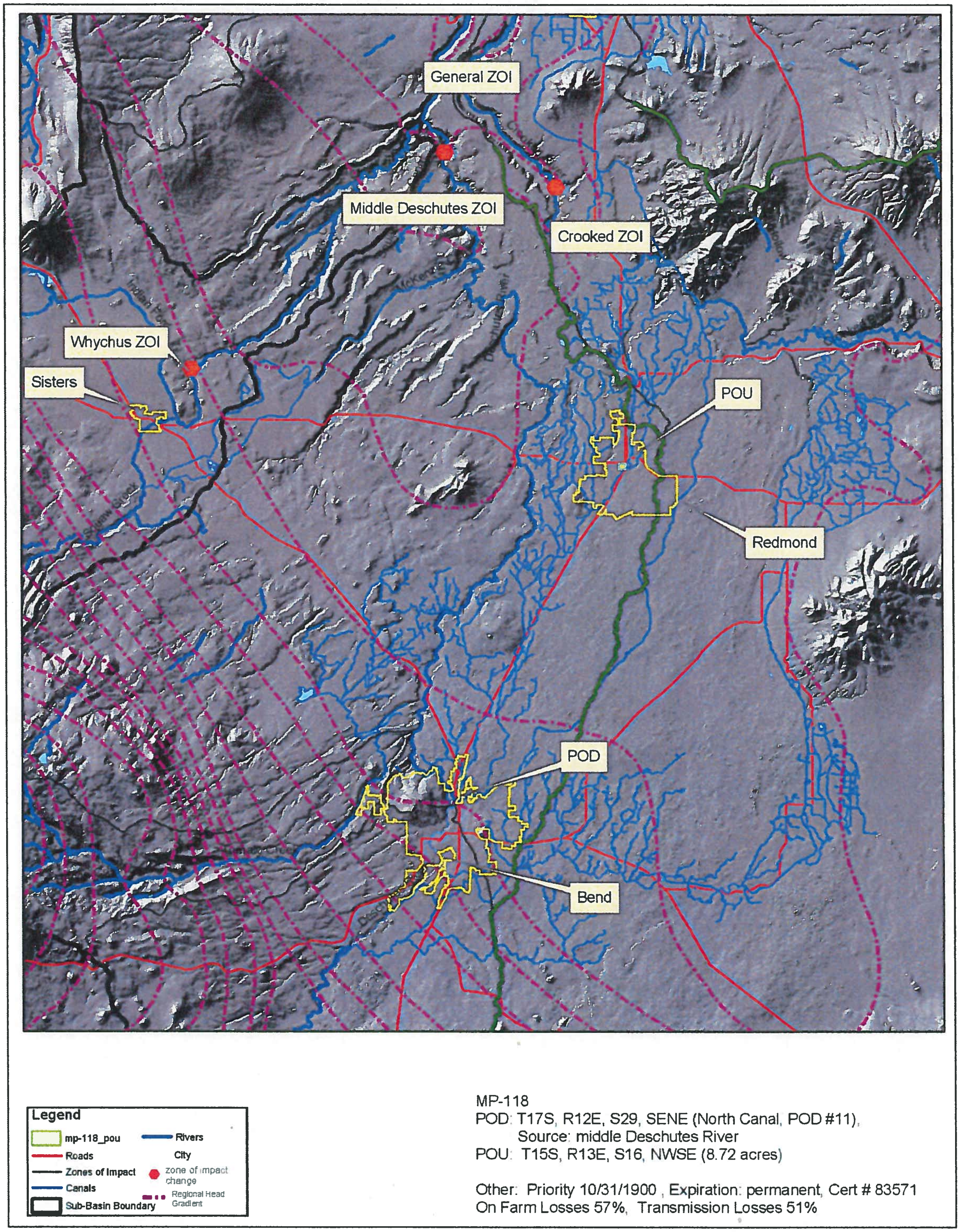
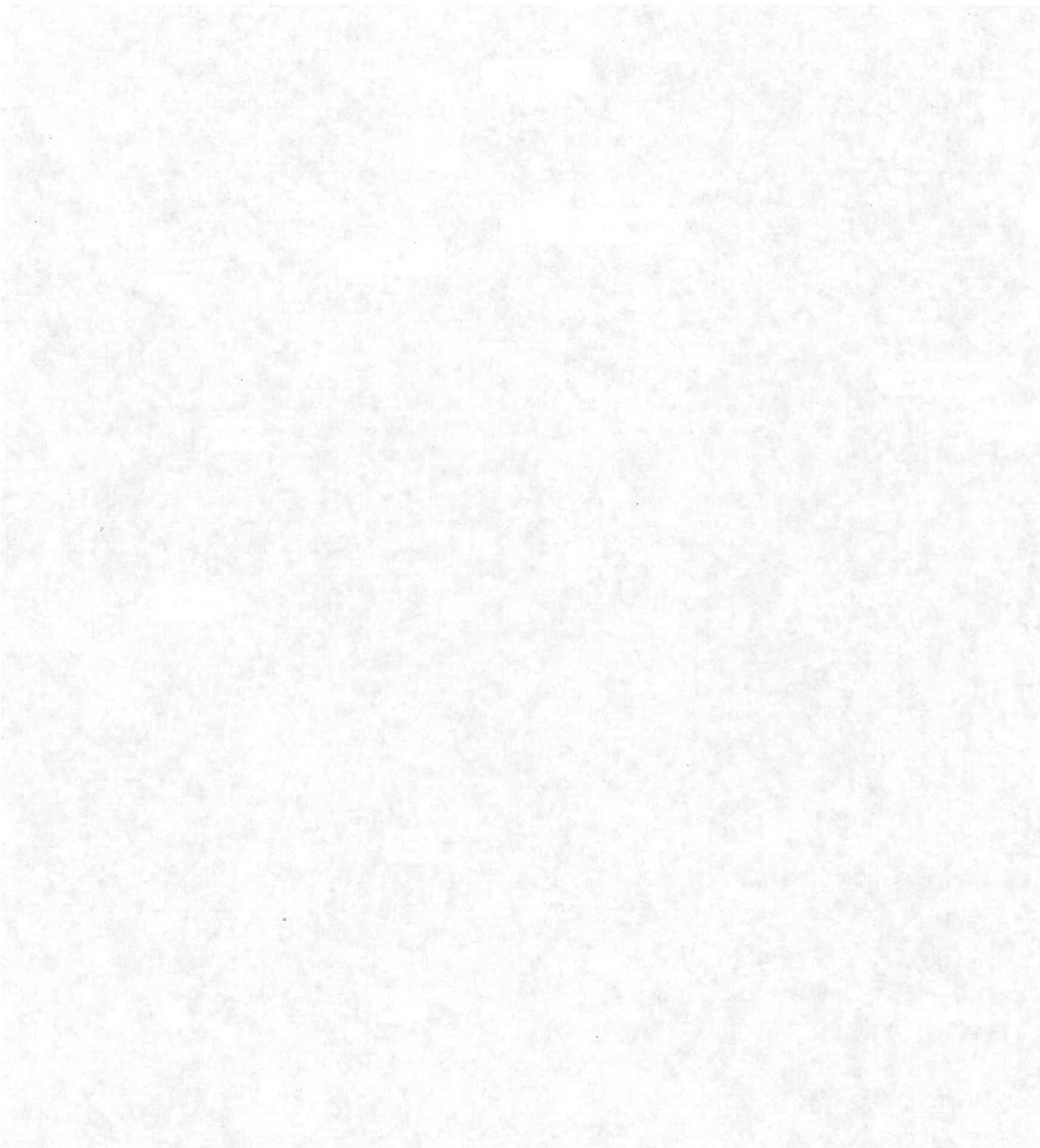


Figure C-1. A map showing the locale near the place of use (POU) for a water right for irrigation that is to be leased in-stream. Shown are the POU, point of diversion (POD), the local zones of impact (ZOI), and contours representing the groundwater head gradient.



Appendix D - Zone of Impact Determination for a Groundwater Withdrawal

By Kenneth E. Lite, Jr.

The hydrologic evaluation to determine which zone of impact is affected by a groundwater withdrawal is made by considering the proposed well's proximity to surface water and to an area of groundwater discharge. Also considered are well construction information, well depth and the portion of the aquifer that the well will produce water from, general ground water flow direction, and other hydrogeologic information. Using this information, it is determined whether the groundwater application must provide mitigation in the general zone of impact or in a local zone of impact.

An Example Evaluation

A well is drilled in Sisters to be used for municipal use. The well is constructed into unconfined water-bearing units within inter-bedded glacial outwash sediment (silt, sand, and gravel) and Cascade lava flows. The elevation of the hydraulic head (water table surface) in the well is above the elevation of the nearest down-gradient ground-water discharge area in Whychus Creek. The most likely surface water to be impacted by the pumping are tributary springs to Whychus Creek at the eastern base of McKinney Butte. Therefore, the local zone of impact is determined to be Whychus Creek.