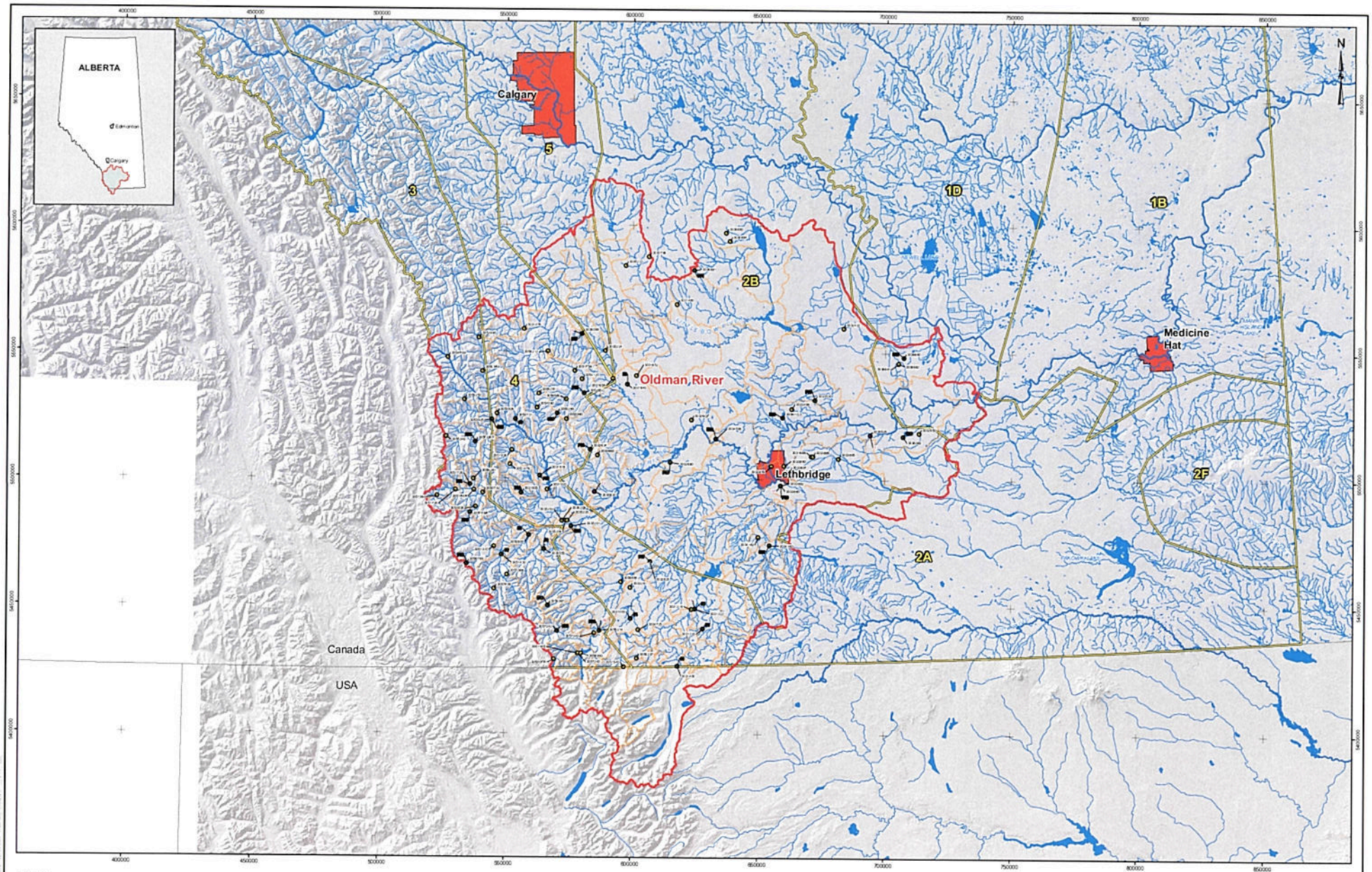
# APPENDIX C

## Oldman River Basin

**July 2010**
**Report No.** 09-1326-1006

Golder Associates




**LEGEND**

- CLIMATE STATION
- INDEX STATION TEMPERATURE
- INDEX STATION PRECIPITATION
- RIVER
- HYDROLOGIC REGION
- LAKE
- MAJOR RIVER BASIN
- PFRA SUB-BASIN

**REFERENCE**

Hydrography and city data for Canada obtained from Natural Resources Canada. Hydrography for the USA obtained from USGS.
Hydrometric stations, hydrologic regions, basin and sub-basin data obtained from Alberta Environment.
Projection: Alberta 10TM False Easting 500,000 at 115° W. Datum: NAD 83

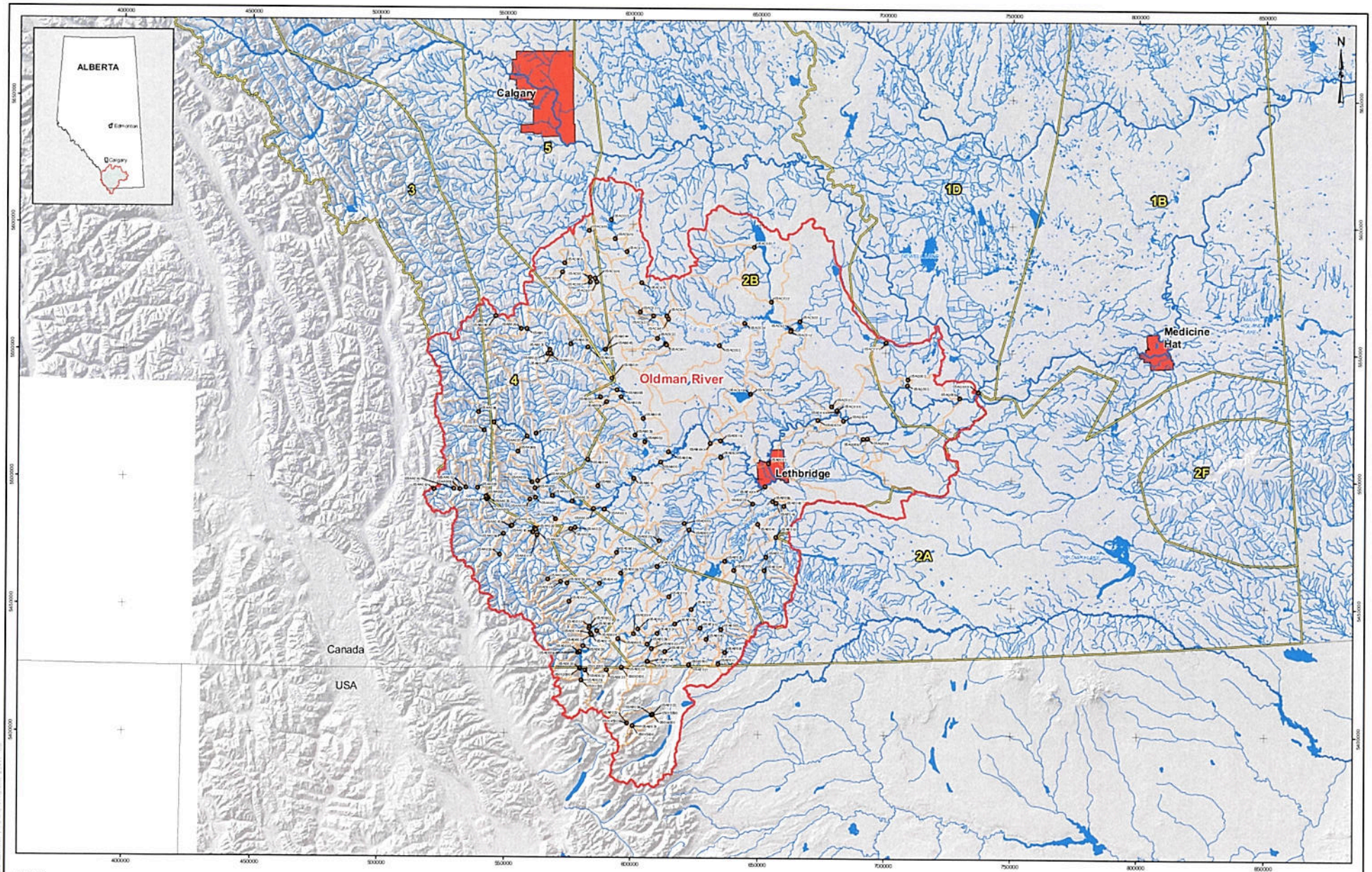
PROJECT
Government of Alberta — Environment
HYDRO-CLIMATE MODELLING OF THE SOUTH SASKATCHEWAN REGIONAL PLANNING AREA

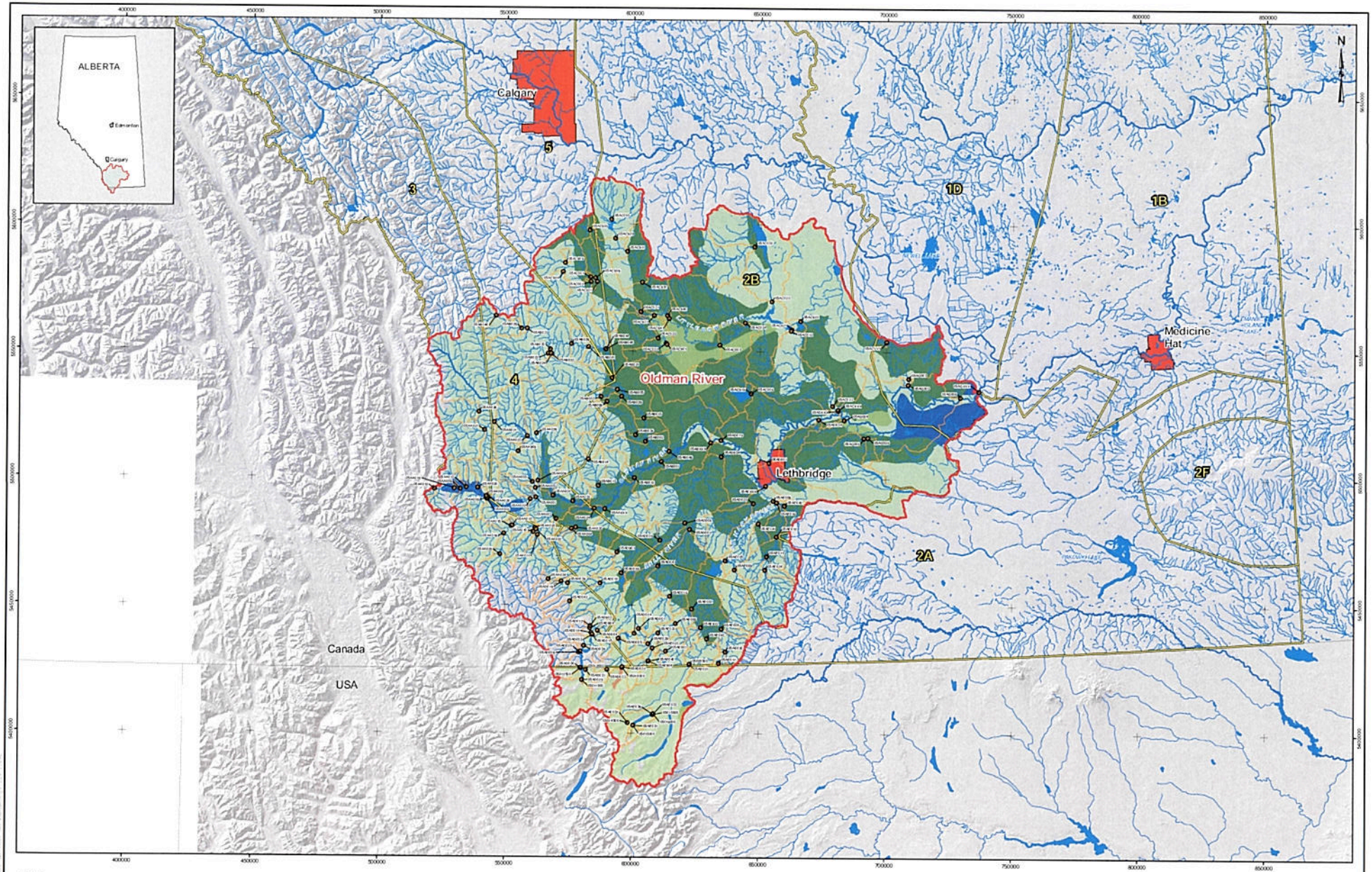
TITLE
**CLIMATE STATIONS IN THE OLDMAN RIVER BASIN**

Golder Associates
Calgary, Alberta

| | | |
|---|---|---|
| PROJECT NO. 09-1326-1005 | | SCALE AS SHOWN | REV. 0 |
| DESIGN | AB | 24 Sep 2009 | |
| GIS | AB | 23 Mar 2010 | |
| CHECK | AB | 28 Jul 2010 | |
| REVIEW | AB | 29 Jul 2010 | |

**FIGURE: C.1**


ALBERTA
Edmonton
Calgary
Calgary
5
3
1D
1B
2B
Medicine Hat
4
Oldman River
Lethbridge
2F
2A
Canada
USA
N
LEGEND
HYDROMETRIC STATION
RIVER
HYDROLOGIC REGION
LAKE
MAJOR RIVER BASIN
PFRA SUB-BASIN
30 0 30
SCALE 1:1,000,000 KILOMETRES
REFERENCE
Hydrography and city data for Canada obtained from Natural Resources Canada. Hydrography for the USA obtained from USGS.
Hydrometric stations, hydrologic regions, basin and sub-basin data obtained from Alberta Environment.
Projection: Alberta 10TM False Easting 500,000 at 115° W. Datum: NAD 83.
PROJECT
Government of Alberta
Environment
HYDRO-CLIMATE MODELLING OF THE SOUTH SASKATCHEWAN REGIONAL PLANNING AREA
TITLE
HYDROMETRIC STATIONS IN THE OLDMAN RIVER BASIN
Golder Associates
Calgary, Alberta
FIGURE: C.2




LEGEND

- HYDROMETRIC STATION
- RIVER
- HYDROLOGIC REGION
- LAKE
- MAJOR RIVER BASIN
- PFRA SUB-BASIN

SOIL TYPE

- IMPERVIOUS
- ORGANIC
- WATER
- POORLY DRAINED CLAY LOAM
- POORLY DRAINED SAND
- POORLY DRAINED TILL
- RAPIDLY DRAINED SAND
- RAPIDLY DRAINED TILL
- WELL DRAINED CLAY LOAM
- WELL DRAINED SAND
- WELL DRAINED TILL
- WELL DRAINED RESIDUAL
- NO DATA

REFERENCE

Hydrography and city data for Canada obtained from Natural Resources Canada. Hydrography for the USA obtained from USGS. Hydrometric stations, hydrologic regions, basin and sub-basin data obtained from Alberta Environment. Surficial Geology for Alberta obtained from Agriculture and Agri-Food Canada. Surficial Geology for Montana obtained from Natural Resources Conservation Service.
Projection: Alberta 10TM False Easting 500,000 at 115° W. Datum: NAD 83

PROJECT

Government of Alberta — Environment

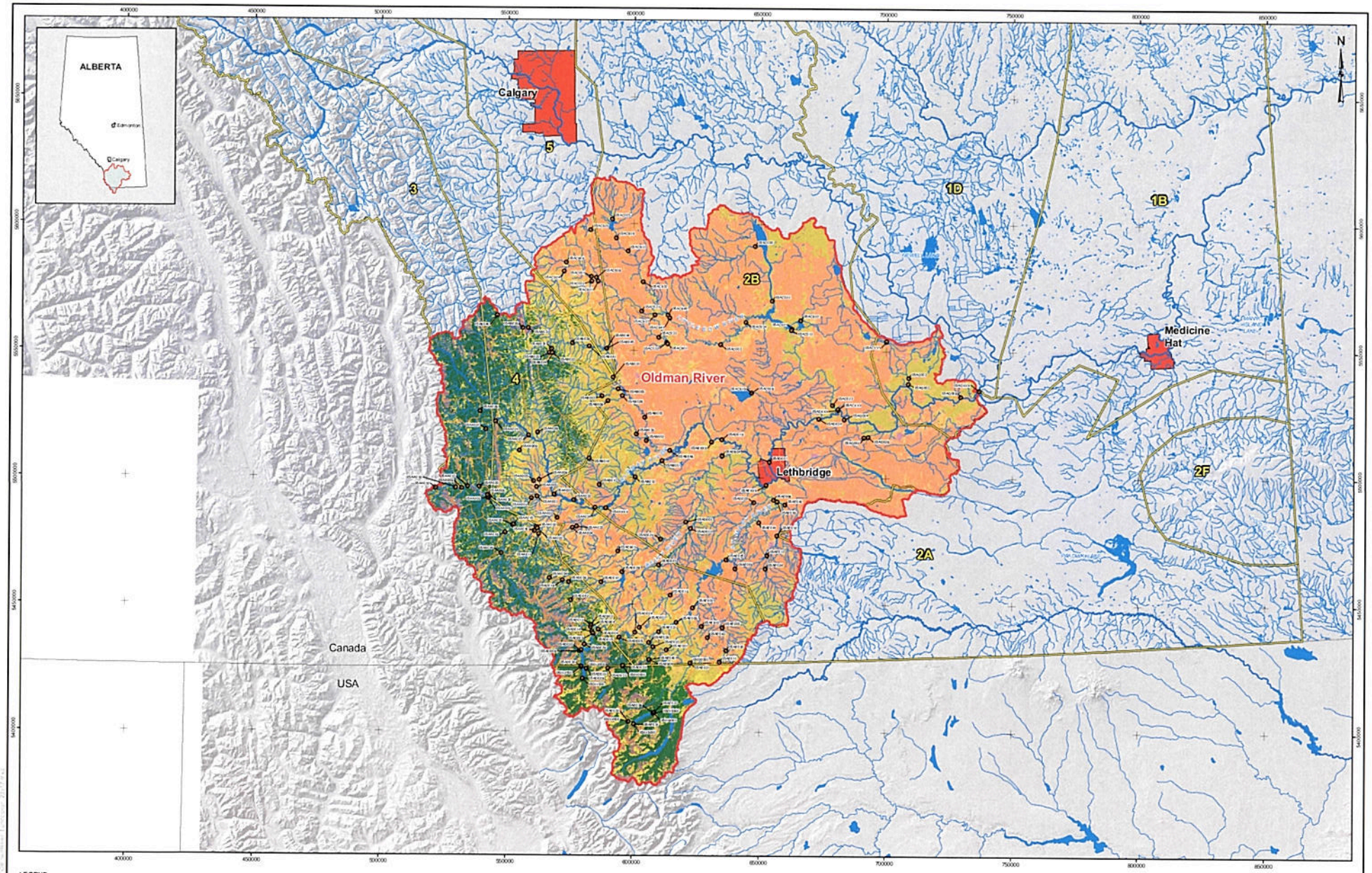
HYDRO-CLIMATE MODELLING OF THE SOUTH SASKATCHEWAN REGIONAL PLANNING AREA

TITLE

SURFICIAL GEOLOGY IN THE OLDMAN RIVER BASIN

Golder Associates
Calgary, Alberta

| PROJECT NO. 09-1326-1004 | | | SCALE AS Shown | REV. 0 |
|---|---|---|---|---|
| DESIGN | LC | 08 Jan 2010 | | |
| G/S | AB | 03 Mar 2010 | | |
| CHECK | AB | 25 Jul 2010 | FIGURE: C.3 | |
| REVIEW | AB | 29 Jul 2010 | | |




**LEGEND**

- HYDROMETRIC STATION
- RIVER
- HYDROLOGIC REGION
- LAKE
- MAJOR RIVER BASIN
- PFRA SUB-BASIN

**LANDCOVER**

- UNCLASSIFIED
- WATER
- EXPOSED LAND
- DEVELOPED
- SHRUBLAND
- WETLAND
- GRASSLAND NATIVE GRASS
- ANNUAL CROPLAND
- PERENNIAL CROPS AND PASTURE
- CONIFEROUS FOREST
- DECIDUOUS FOREST
- MIXED FOREST

30 0 30

SCALE 1:1,000,000 KILOMETRES

**REFERENCE**

Hydrography and city data for Canada obtained from Natural Resources Canada. Hydrography for the USA obtained from USGS. Hydrometric stations, hydrologic regions, basin and sub-basin data obtained from Alberta Environment. Landcover for Canada obtained from Agriculture and Agri-Food Canada. Landcover for the USA obtained from USGS.
Projection: Alberta 10TM False Easting 500,000 at 115° W. Datum: NAD 83.

PROJECT
Government of Alberta
Environment

HYDRO-CLIMATE MODELLING OF THE SOUTH SASKATCHEWAN REGIONAL PLANNING AREA

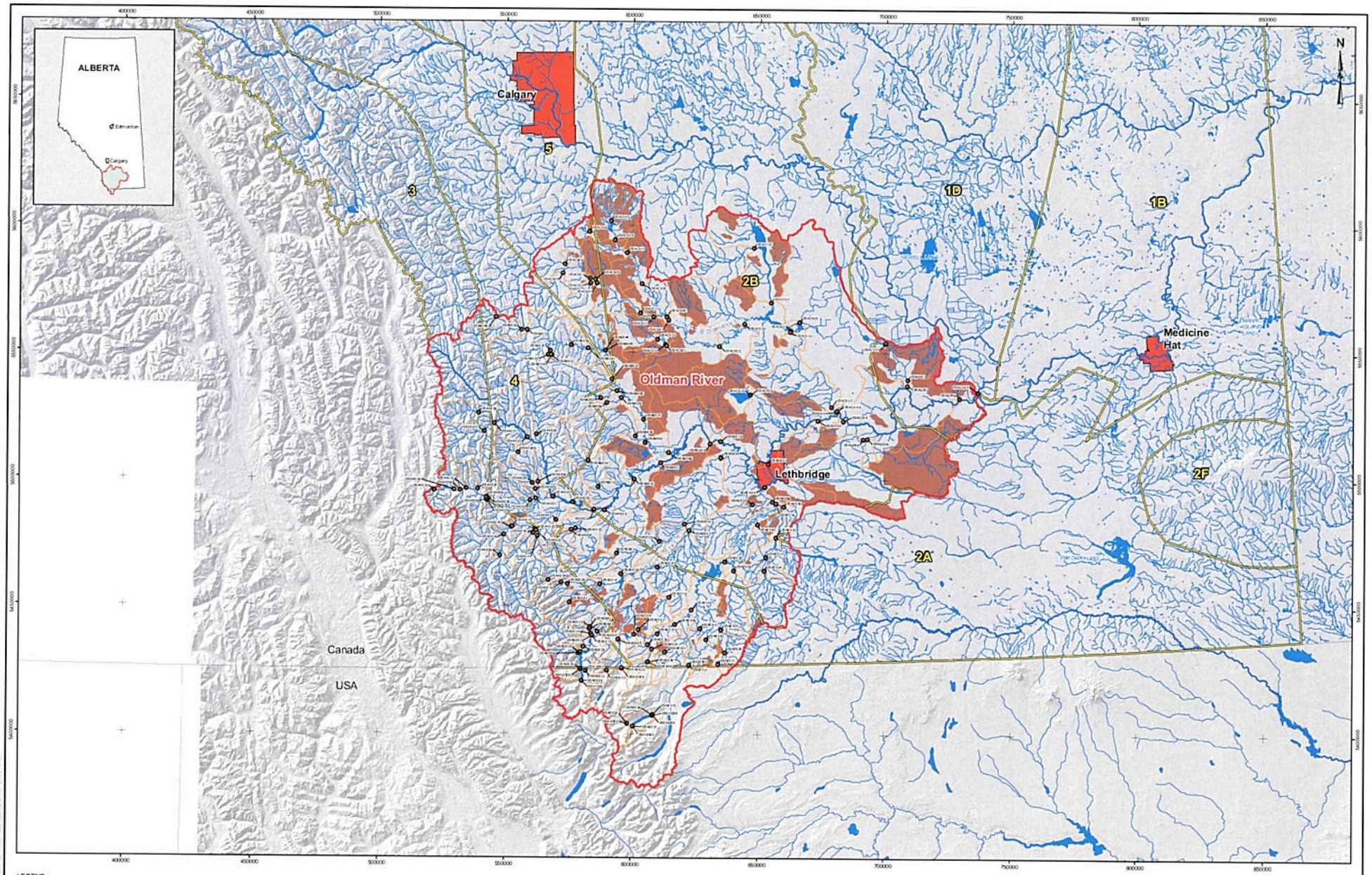
TITLE

**LAND COVER IN THE OLDMAN RIVER BASIN**

Golder Associates
Calgary, Alberta

| | | |
|---|---|---|
| PROJECT NO. 09-1336-1004 | | SCALE AS SHOWN | REV. 0 |
| DESIGN | LC | 04 Jan 2010 | |
| GIS | AB | 22 Mar 2010 | |
| CHECK | AB | 25 Jul 2010 | |
| REVIEW | AB | 25 Jul 2010 | |

**FIGURE: C.4**




LEGEND

- HYDROMETRIC STATION
- RIVER
- HYDROLOGIC REGION
- LAKE
- MAJOR RIVER BASIN
- NON-CONTRIBUTING AREA
- PFRA SUB-BASIN

30 0 30

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Hydrography and city data for Canada obtained from Natural Resources Canada. Hydrography for the USA obtained from USGS.
Hydrometric stations, hydrologic regions, basin and sub-basin data obtained from Alberta Environment.
Projection: Alberta 10TM False Easting 500,000 at 115° W. Datum: NAD 83

PROJECT
Government of Alberta
Environment

HYDRO-CLIMATE MODELLING OF THE SOUTH SASKATCHEWAN REGIONAL PLANNING AREA

TITLE

**NON-CONTRIBUTING AREAS IN THE OLDMAN RIVER BASIN**

Golder Associates
Calgary, Alberta

| | | | |
|---|---|---|---|
| PROJECT NO. 09-1336-1004 | | | SCALE AS SHOWN REV. 0 |
| DESIGN | LC | 26 Jan. 2010 | |
| GIS | AB | 29 Mar. 2010 | |
| CHECK | AB | 29 Jul. 2010 | |
| REVIEW | AB | 29 Jul. 2010 | |

**FIGURE: C.5**

Figure C.6 HSPF Schematic for the Upper and Lower Portions of the Oldman River Basin

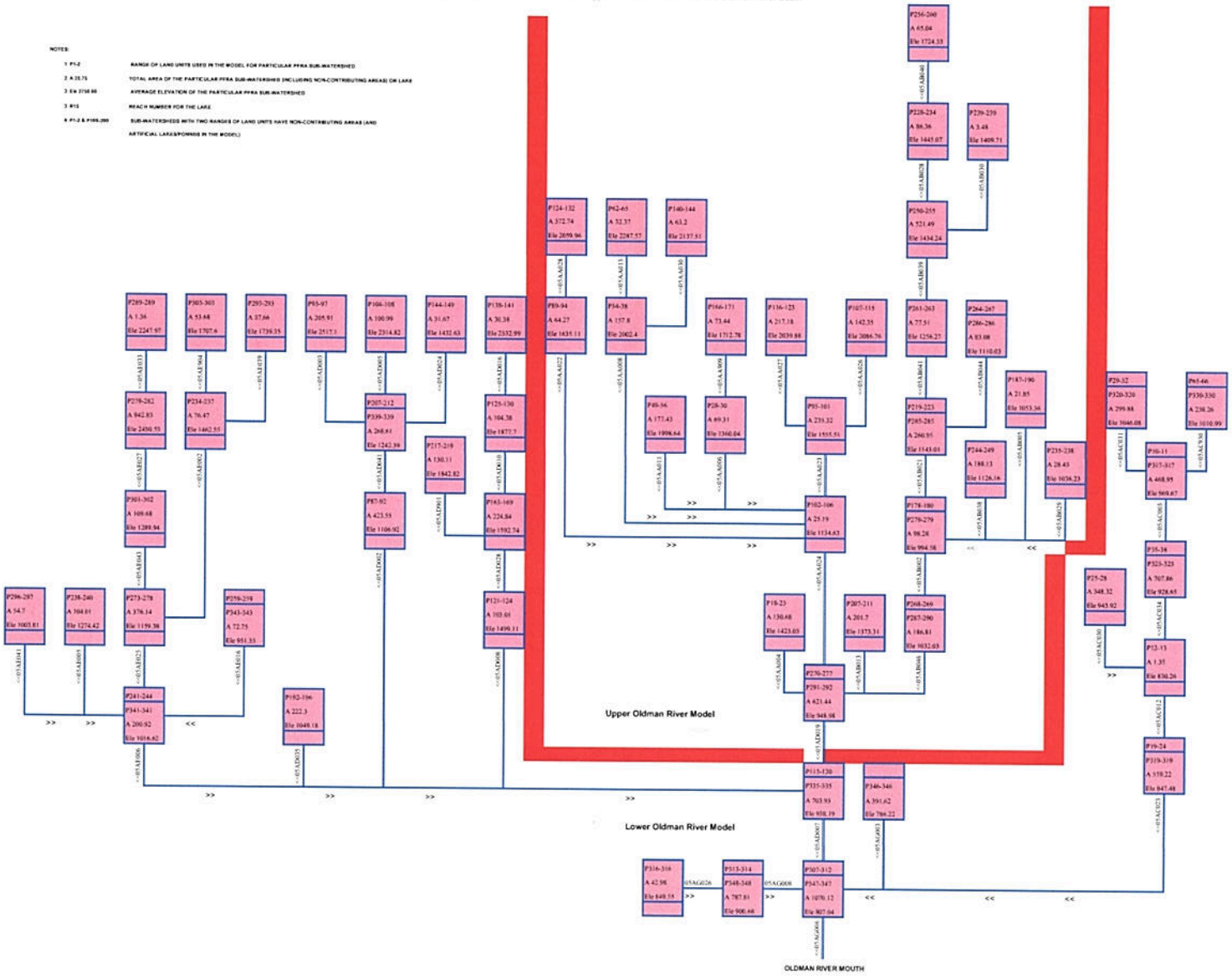


**Table C.1a Calibrated HSPF Parameters for the UPPER Portion of the Oldman River Basin**

**Pervious Land Parameters**

| Land Type | Parameter | FOREST | LZSN | INFILT | KVARY | AGWRC | PETMAX | PETMIN | INFEXP | INFILD | DEEPFR | BASETP | AGWETP | CEPSC | UZSN | NSUR | INTFW | IRC | LZETP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Description | The fraction of the pervious land segment which is covered by forest | The lower zone nominal storage | An index to the infiltration capacity of the soil | parameter which affects the behavior of groundwater recession flow, enabling it to be non-exponential in its decay with time | The basic groundwater recession rate if KVARY is zero and there is no inflow to groundwater. | The air temperature below which E-T will arbitrarily be reduced below the value obtained from the input time series. | The temperature below which E-T will be zero regardless of the value in the input time series. | Exponent in the infiltration equation | Ratio between the maximum and mean infiltration capacities | Fraction of groundwater inflow which will enter deep (inactive) groundwater | Fraction of remaining potential E-T which can be satisfied from baseflow (groundwater outflow), if enough is available. | Fraction of remaining potential E-T which can be satisfied from active groundwater storage if enough is available. | Interception storage capacity. | Upper zone nominal storage. | Manning's n for the overland flow plane. | Interflow inflow parameter. | Interflow recession parameter | Lower zone E-T parameter. |
| | Units | none | in | in/hr | 1/in | 1/day | degF | degF | none | none | none | none | none | in | in | complex | none | 1/day | none |
| Impervious + Coniferous Forest | | 0.5 | 0.3 | 0.1 | 0-0.5 | 0.983 | 40 | 35 | 2 | 2 | 0 | 0.005-0.015 | 0.005-0.015 | see monthly table | 0.01 | 0.35 | 0-8 | 0.85 | see monthly table |
| Impervious + Exposed Land | | 0.5 | 0.3 | 0.1 | 0-0.5 | 0.983 | 40 | 35 | 2 | 2 | 0 | 0.005-0.015 | 0.005-0.015 | see monthly table | 0.01 | 0.35 | 0-8 | 0.85 | see monthly table |
| Impervious + Grassland Native Grass | | 0.5 | 0.3 | 0.1 | 0-0.5 | 0.983 | 40 | 35 | 2 | 2 | 0 | 0.005-0.015 | 0.005-0.015 | see monthly table | 0.01 | 0.35 | 0-8 | 0.85 | see monthly table |
| Impervious + Mixed Forest | | 0.5 | 0.3 | 0.1 | 0.5 | 0.983 | 40 | 35 | 2 | 2 | 0 | 0.005 | 0.005 | see monthly table | 0.01 | 0.35 | 8 | 0.85 | see monthly table |
| Impervious + Shrubland | | 0.5 | 0.3 | 0.1 | 0-0.5 | 0.983 | 40 | 35 | 2 | 2 | 0 | 0.005-0.015 | 0.005-0.015 | see monthly table | 0.01 | 0.35 | 0-8 | 0.85 | see monthly table |
| Well Drained Clay Loam + Annual Cropland | | 0.3 | 0.25 | 0.15 | 1.2 | 0.938-0.999 | 35-40 | 32-35 | 2 | 2 | 0-1 | 0.005-0.4 | 0.01-0.4 | see monthly table | 0.1 | 0.25 | 2 | 0.8 | see monthly table |
| Well Drained Clay Loam + Developed | | 0 | 0.25 | 0.15 | 1.2 | 0.938 | 40 | 35 | 2 | 2 | 0 | 0.005 | 0.01 | see monthly table | 0.1 | 0.25 | 2 | 0.8 | see monthly table |
| Well Drained Clay Loam + Exposed Land | | 0 | 3.3 | 0.0173 | 1.18 | 0.938 | 40 | 35 | 2 | 2 | 0 | 0.005 | 0.01 | see monthly table | 0.1 | 0.25 | 2 | 0.8 | see monthly table |
| Well Drained Clay Loam + Grassland Native Grass | | 0.3 | 0.25 | 0.15 | 1.2 | 0.938-0.999 | 35-40 | 32-35 | 2 | 2 | 0-1 | 0.005-0.4 | 0.01-0.4 | see monthly table | 0.1 | 0.25 | 2 | 0.8 | see monthly table |
| Well Drained Clay Loam + Perrenial Crops and Pasture | | 0.8 | 0.25 | 0.15 | 1.2 | 0.938-0.999 | 35-40 | 32-35 | 2 | 2 | 0-1 | 0.005-0.4 | 0.01-0.4 | see monthly table | 0.1 | 0.25 | 2 | 0.8 | see monthly table |
| Well Drained Clay Loam + Shrubland | | 0.3 | 3.3 | 0.0173 | 1.18 | 0.938 | 35-40 | 32-35 | 2 | 2 | 0-1 | 0.005-0.2 | 0.01-0.2 | see monthly table | 0.3 | 0.25 | 1 | 0.534 | see monthly table |
| Well Drained Sand + Coniferous Forest | | 0.8 | 2 | 0.5 | 1.5-3.0 | 0.993 | 40 | 35 | 2 | 2 | 0 | 0.005 | 0.005-0.01 | see monthly table | 0.2 | 0.25 | 5 | 0.85-0.998 | see monthly table |
| Well Drained Sand + Grassland Native Grass | | 0.3 | 2 | 0.5 | 3 | 0.995 | 40 | 35 | 2 | 2 | 0 | 0.005 | 0.01 | see monthly table | 0.2 | 0.25 | 5 | 0.85 | see monthly table |
| Well Drained Sand + Shrubland | | 0.3 | 2 | 0.5 | 0 | 0.995 | 40 | 35 | 2 | 2 | 0 | 0.02 | 0.02 | see monthly table | 0.2 | 0.75 | 8 | 0.85 | see monthly table |
| Well Drained Till + Annual Cropland | | 0.3 | 0.3 | 0.1 | 1.5 | 0.983-0.999 | 35-40 | 32-35 | 2 | 2 | 0-1 | 0.005-0.4 | 0.005-0.4 | see monthly table | 0.05 | 0.25 | 3.3 | 0.85 | see monthly table |
| Well Drained Till + Coniferous Forest | | 0.6 | 0.8 | 0.2 | 1.5 | 0.983-0.993 | 35-40 | 32-35 | 2 | 2 | 0-1 | 0.005-0.2 | 0.005-0.2 | see monthly table | 0.05 | 0.75 | 0.3-3.3 | 0.85 | see monthly table |
| Well Drained Till + Deciduous Forest | | 0.5 | 0.8 | 0.2 | 1.5 | 0.983-0.993 | 35-40 | 32-35 | 2 | 2 | 0-1 | 0.005-0.2 | 0.005-0.2 | see monthly table | 0.05 | 0.75 | 0.3-3.3 | 0.85 | see monthly table |
| Well Drained Till + Exposed Land | | 0 | 0.8 | 0.2 | 1.5 | 0.993 | 40 | 35 | 2 | 2 | 0-0.8 | 0.005-0.015 | 0.005-0.015 | see monthly table | 0.05 | 0.75 | 0.3-3.3 | 0.85 | see monthly table |
| Well Drained Till + Grassland Native Grass | | 0.3 | 0.8 | 0.2 | 1.5 | 0.983-0.999 | 35-40 | 32-35 | 2 | 2 | 0-1 | 0.005-0.4 | 0.005-0.4 | see monthly table | 0.05 | 0.75 | 0.3-3.3 | 0.85 | see monthly table |
| Well Drained Till + Mixed Forest | | 0.5 | 0.8 | 0.2 | 1.5 | 0.983-0.993 | 35-40 | 32-35 | 2 | 2 | 0-0.8 | 0.005-0.008 | 0.005-0.08 | see monthly table | 0.05 | 0.75 | 0.3-3.3 | 0.85 | see monthly table |
| Well Drained Till + Perrenial Crops and Pasture | | 0.5 | 0.8 | 0.2 | 1.5 | 0.983-0.999 | 35-40 | 32-35 | 2 | 2 | 0-1 | 0.005-0.2 | 0.005-0.2 | see monthly table | 0.05 | 0.75 | 0.3-3.3 | 0.85 | see monthly table |
| Well Drained Till + Shrubland | | 0.3 | 0.8 | 0.2 | 1.5 | 0.983-0.999 | 35-40 | 32-35 | 2 | 2 | 0-1 | 0.005-0.2 | 0.005-0.2 | see monthly table | 0.05 | 0.75 | 0.3-3.3 | 0.85 | see monthly table |

**Monthly Interception**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Impervious + Coniferous Forest | 0.01 | 0.01 | 0.01 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0.01 |
| Impervious + Exposed Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Impervious + Grassland Native Grass | 0.01 | 0.01 | 0.01 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0.01 |
| Impervious + Mixed Forest | 0.01 | 0.01 | 0.01 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0.01 |
| Impervious + Shrubland | 0.01 | 0.01 | 0.01 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0.01 |
| Well Drained Clay Loam + Annual Cropland | 0 | 0 | 0 | 0 | 0.05 | 0.1 | 0.05 | 0.35 | 0.4 | 0.4 | 0 | 0 |
| Well Drained Clay Loam + Developed | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Clay Loam + Exposed Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Clay Loam + Grassland Native Grass | 0.01 | 0.01 | 0.01 | 0.05 | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.05 | 0.01 |
| Well Drained Clay Loam + Perrenial Crops and Pasture | 1.8 | 1.5 | 1.2 | 0.4 | 0.05 | 0.1 | 0.05 | 0.35 | 0.4 | 0.4 | 0.4 | 1.5 |
| Well Drained Clay Loam + Shrubland | 1.8 | 1.5 | 1.2 | 0.4 | 0.05 | 0.1 | 0.05 | 0.35 | 0.4 | 0.4 | 0.4 | 1.5 |
| Well Drained Sand + Coniferous Forest | 0.5 | 0.5 | 0.1 | 0.1 | 0.05 | 0.05 | 0.05 | 0.35 | 0.4 | 0.4 | 0.4 | 0.4 |
| Well Drained Sand + Grassland Native Grass | 0.01 | 0.01 | 0.01 | 0.05 | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.05 | 0.01 |
| Well Drained Sand + Shrubland | 0.01 | 0.01 | 0.01 | 0.05 | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.05 | 0.01 |
| Well Drained Till + Annual Cropland | 0 | 0 | 0 | 0 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0 |
| Well Drained Till + Coniferous Forest | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.15 | 0.15 | 0.2 | 0.3 | 0.3 | 0.2 | 0.05 |
| Well Drained Till + Deciduous Forest | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.15 | 0.15 | 0.2 | 0.3 | 0.3 | 0.2 | 0.05 |
| Well Drained Till + Exposed Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Till + Grassland Native Grass | 0.1 | 0.1 | 0.1 | 0.5 | 0.1 | 0.15 | 0.15 | 0.2 | 0.3 | 0.3 | 0.2 | 0.01 |
| Well Drained Till + Mixed Forest | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.15 | 0.15 | 0.2 | 0.3 | 0.3 | 0.2 | 0.05 |
| Well Drained Till + Perrenial Crops and Pasture | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.15 | 0.15 | 0.2 | 0.3 | 0.3 | 0.2 | 0.01 |
| Well Drained Till + Shrubland | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.15 | 0.15 | 0.2 | 0.3 | 0.3 | 0.2 | 0.05 |

**Lower Zone Evapotranspiration**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Impervious + Coniferous Forest | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 | 0.1 | 0.01 |
| Impervious + Exposed Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Impervious + Grassland Native Grass | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 | 0.1 | 0.01 |
| Impervious + Mixed Forest | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 | 0.1 | 0.01 |
| Impervious + Shrubland | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 | 0.1 | 0.01 |
| Well Drained Clay Loam + Annual Cropland | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.2 | 0.4 | 0.5 | 0.5 | 0 | 0 |
| Well Drained Clay Loam + Developed | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Clay Loam + Exposed Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Clay Loam + Grassland Native Grass | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 |
| Well Drained Clay Loam + Perrenial Crops and Pasture | 0.3 | 0.5 | 0.6 | 0.8 | 0.2 | 0.2 | 0.2 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 |
| Well Drained Clay Loam + Shrubland | 0.3 | 0.5 | 0.6 | 0.8 | 0.2 | 0.2 | 0.2 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 |
| Well Drained Sand + Coniferous Forest | 0.3 | 0.5 | 0.6 | 0.8 | 0.2 | 0.2 | 0.2 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 |
| Well Drained Sand + Grassland Native Grass | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 |
| Well Drained Sand + Shrubland | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 |
| Well Drained Till + Annual Cropland | 0 | 0 | 0 | 0 | 0.2 | 0.45 | 0.45 | 0.45 | 0.2 | 0.1 | 0 | 0 |
| Well Drained Till + Coniferous Forest | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 | 0.1 | 0.01 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well Drained Till + Deciduous Forest | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 | 0.1 | 0.01 |
| Well Drained Till + Exposed Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Till + Grassland Native Grass | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 | 0.1 | 0.01 |
| Well Drained Till + Mixed Forest | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 | 0.1 | 0.01 |
| Well Drained Till + Perrenial Crops and Pasture | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 | 0.1 | 0.01 |
| Well Drained Till + Shrubland | 0.01 | 0.01 | 0.01 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 | 0.1 | 0.01 |

**Snow Parameters**

| | | SHADE | SNOWCF | COVIND | KMELT | TBASE | RDCSN | TSNOW | SNOEVP | CCFACT | MWATER | MGMELT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Description | The fraction of the land which is shaded from solar radiation by trees | Factor by which the input precipitation data will be multiplied | The maximum snowpack (water equivalent) at which the entire land will be covered with snow | Constant degree-day factor for the temperature index snowmelt method | The reference temperature for the temperature index method | The density of cold, new snow relative to water | The air temperature below which precipitation will be snow | A parameter which adapts the snow evaporation (sublimation) equation to field conditions | A parameter which adapts the snow condensation/convection melt equation to field conditions. | The maximum water content of the snow pack, in depth of water per depth of water | The maximum rate of snowmelt by ground heat, in depth of water per day |
| | Units | none | none | none | in/day-F | degF | none | degF | none | none | none | in/day |
| Impervious + Coniferous Forest | | 0.5 | 1-1.3 | 0.3-10 | 0 | 32 | 0.2 | 40 | 0.1-0.3 | 0.001-0.01 | 0.5-1 | 0.00 |
| Impervious + Exposed Land | | 0.5 | 1-1.3 | 0.3-10 | 0 | 32 | 0.2 | 40 | 0.1-0.3 | 0.001-0.01 | 0.3-1 | 0-1.0 |
| Impervious + Grassland Native Grass | | 0.5 | 1-1.3 | 0.3-5.3 | 0 | 32 | 0.2 | 40 | 0.1-0.3 | 0.001-0.01 | 0.5-1 | 0 |
| Impervious + Mixed Forest | | 0.5 | 1.3 | 5.3 | 0 | 32 | 0.2 | 40 | 0.1 | 0.01 | 0.8 | 0 |
| Impervious + Shrubland | | 0.5 | 1-1.3 | 0.3-5.3 | 0 | 32 | 0.2 | 40 | 0.1-0.3 | 0.001-0.01 | 0.5-1 | 0 |
| Well Drained Clay Loam + Annual Cropland | | 0.6 | 1 | 6.0-10.0 | 0 | 32 | 0.2 | 40 | 0.4-0.8 | 0.001-0.05 | 0.8-1 | 0 |
| Well Drained Clay Loam + Developed | | 0.5 | 1 | 5 | 0 | 32 | 0.2 | 40 | 0.4 | 0.001 | 1 | 0 |
| Well Drained Clay Loam + Exposed Land | | 0.1 | 1 | 7 | 0 | 32 | 0.2 | 40 | 0.3 | 0.001 | 1 | 0.1 |
| Well Drained Clay Loam + Grassland Native Grass | | 0.6 | 1 | 6.0-10.0 | 0 | 32 | 0.2 | 40 | 0.4-0.8 | 0.001-0.05 | 0.8-1 | 0 |
| Well Drained Clay Loam + Perrenial Crops and Pasture | | 0.8 | 1 | 8 | 0 | 32 | 0.2 | 40 | 0.35-0.75 | 0.001-0.05 | 0.8-1 | 0 |
| Well Drained Clay Loam + Shrubland | | 0.3 | 1 | 7 | 0 | 32 | 0.2 | 40 | 0.3-0.7 | 0.001-0.05 | 0.8-1 | 0 |
| Well Drained Sand + Coniferous Forest | | 0.8 | 1 | 6.0-8.0 | 0 | 32 | 0.2 | 40 | 0.2-0.35 | 0.001-0.01 | 0.8-1 | 0 |
| Well Drained Sand + Grassland Native Grass | | 0.6 | 1 | 6 | 0 | 32 | 0.2 | 40 | 0.4 | 0.001 | 1 | 0 |
| Well Drained Sand + Shrubland | | 0.3-0.5 | 1 | 6 | 0 | 32 | 0.2 | 40 | 0.2-0.3 | 0.001-0.01 | 0.8-1 | 0 |
| Well Drained Till + Annual Cropland | | 0.7 | 1-1.3 | 2.0-10.0 | 0 | 32 | 0.2 | 40 | 0.2-0.7 | 0.001-0.05 | 0.8-1 | 0 |
| Well Drained Till + Coniferous Forest | | 0.7 | 1-1.3 | 0.05-10.0 | 0 | 32 | 0.2 | 32-40 | 0.1-0.8 | 0.001-0.05 | 0.8-1 | 0 |
| Well Drained Till + Deciduous Forest | | 0.7 | 1-1.3 | 0.05-10.0 | 0 | 32 | 0.2 | 32-40 | 0.3-0.8 | 0.001-0.05 | 0.8-1 | 0 |
| Well Drained Till + Exposed Land | | 0.3 | 1-1.3 | 0.05-10.0 | 0 | 32 | 0.2 | 32-40 | 0.2-0.3 | 0.001-0.01 | 0.3-1 | 0-1 |
| Well Drained Till + Grassland Native Grass | | 0.7 | 1-1.3 | 0.05-10.0 | 0 | 32 | 0.2 | 32-40 | 0.2-0.7 | 0.001-0.05 | 0.5-1 | 0 |
| Well Drained Till + Mixed Forest | | 0.8 | 1-1.3 | 0.05-10.0 | 0 | 32 | 0.2 | 32-40 | 0.2-0.7 | 0.001-0.05 | 0.8-1 | 0 |
| Well Drained Till + Perrenial Crops and Pasture | | 0.5 | 1-1.3 | 0.05-10.0 | 0 | 32 | 0.2 | 32-40 | 0.2-0.7 | 0.001-0.05 | 0.5-1 | 0 |
| Well Drained Till + Shrubland | | 0.5 | 1-1.3 | 0.05-10.0 | 0 | 32 | 0.2 | 32-40 | 0.1-0.8 | 0.001-0.05 | 0.8-1 | 0 |

**Table C.1b Calibrated HSPF Parameters for the LOWER Portion of the Oldman River Basin**

**Pervious Land Parameters**

| Land Type | Parameter | FOREST | LZSN | INFILT | KVARY | AGWRC | PETMAX | PETMIN | INFEXP | INFILD | DEEPFR | BASETP | AGWETP | CEPSC | UZSN | NSUR | INTFW | IRC | LZETP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Description | The fraction of the pervious land segment which is covered by forest | The lower zone nominal storage | An index to the infiltration capacity of the soil | parameter which affects the behavior of groundwater recession flow, enabling it to be non-exponential in its decay with time | The basic groundwater recession rate if KVARY is zero and there is no inflow to groundwater. | The air temperature below which E-T will arbitrarily be reduced below the value obtained from the input time series. | The temperature below which E-T will be zero regardless of the value in the input time series. | Exponent in the infiltration equation | Ratio between the maximum and mean infiltration capacities | Fraction of groundwater inflow which will enter deep (inactive) groundwater | Fraction of remaining potential E-T which can be satisfied from baseflow (groundwater outflow), if enough is available. | Fraction of remaining potential E-T which can be satisfied from active groundwater storage if enough is available. | Interception storage capacity. | Upper zone nominal storage. | Manning's n for the overland flow plane. | Interflow inflow parameter. | Interflow recession parameter | Lower zone E-T parameter. |
| | Units | none | in | in/hr | 1/in | 1/day | degF | degF | none | none | none | none | none | in | in | complex | none | 1/day | none |
| Impervious + Coniferous Forest | | 0.5 | 0.3 | 0.008 | 0 | 0.87-0.97 | 40 | 35 | 2 | 2 | 0.3 | 0.2 | 0.2 | see monthly table | 0.5 | 0.35 | 8 | 0.925 | see monthly table |
| Impervious + Deciduous Forest | | 0.5 | 0.3 | 0.008 | 0 | 0.97 | 40 | 35 | 2 | 2 | 0.3 | 0.2 | 0.2 | see monthly table | 0.5 | 0.35 | 8 | 0.925 | see monthly table |
| Impervious + Exposed Land | | 0.5 | 0.3 | 0.008 | 0 | 0.87-0.97 | 40 | 35 | 2 | 2 | 0-0.3 | 0.2 | 0.2 | see monthly table | 0.5 | 0.35 | 8 | 0.925 | see monthly table |
| Impervious + Grassland Native Grass | | 0.5 | 0.3 | 0.008 | 0 | 0.87-0.97 | 40 | 35 | 2 | 2 | 0.3 | 0.2 | 0.2 | see monthly table | 0.5 | 0.35 | 8 | 0.925 | see monthly table |
| Impervious + Mixed Forest | | 0.5 | 0.3 | 0.008 | 0 | 0.97 | 40 | 35 | 2 | 2 | 0.3 | 0.2 | 0.2 | see monthly table | 0.5 | 0.35 | 8 | 0.925 | see monthly table |
| Impervious + Shrubland | | 0.5 | 0.3 | 0.008 | 0 | 0.87-0.97 | 40 | 35 | 2 | 2 | 0.3 | 0.2 | 0.2 | see monthly table | 0.5 | 0.35 | 8 | 0.925 | see monthly table |
| Well Drained Clay Loam + Annual Cropland | | 0.3 | 0.25 | 0.15 | 1.2 | 0.938-0.998 | 40 | 35 | 2 | 2 | 0.3 | 0.2 | 0.2 | see monthly table | 0.5 | 0.35 | 8 | 0.925 | see monthly table |
| Well Drained Clay Loam + Developed | | 0 | 0.25 | 0.15 | 1.2 | 0.938 | 40 | 35 | 2 | 2 | 0-1 | 0.2 | 0.2 | see monthly table | 0.1 | 0.25 | 2 | 0.8-0.9 | see monthly table |
| Well Drained Clay Loam + Exposed Land | | 0 | 3.3 | 0.0173 | 1.18 | 0.938 | 40 | 35 | 2 | 2 | 1 | 1 | 1 | see monthly table | 0.1 | 0.25 | 2 | 0.8 | see monthly table |
| Well Drained Clay Loam + Grassland Native Grass | | 0.3 | 0.25 | 0.15 | 1.2 | 0.938-0.998 | 40 | 35 | 2 | 2 | 1 | 0.2 | 0.2 | see monthly table | 0.3 | 0.25 | 1 | 0.534 | see monthly table |
| Well Drained Clay Loam + Perrenial Crops and Pasture | | 0.8 | 0.25 | 0.15 | 1.2 | 0.938-0.998 | 40 | 35 | 2 | 2 | 0-1 | 0.005-1 | 0.01-1 | see monthly table | 0.1 | 0.25 | 2 | 0.8-0.9 | see monthly table |
| Well Drained Clay Loam + Shrubland | | 0.3 | 3.3 | 0.0173 | 1.18 | 0.938-0.998 | 40 | 35 | 2 | 2 | 0-1 | 0.005-1 | 0.01-1 | see monthly table | 0.1 | 0.25 | 2 | 0.8-0.9 | see monthly table |
| Well Drained Sand + Annual Cropland | | 0.3 | 2 | 0.5 | 3 | 0.995 | 40 | 35 | 2 | 2 | 0-0.3 | 0.005 | 0.01 | see monthly table | 0.3 | 0.25 | 1 | 0.534-0.934 | see monthly table |
| Well Drained Sand + Grassland Native Grass | | 0.3 | 2 | 0.5 | 3 | 0.995 | 40 | 35 | 2 | 2 | 1 | 1 | 1 | see monthly table | 0.2 | 0.25 | 5 | 0.85 | see monthly table |
| Well Drained Sand + Perrenial Crops and Pasture | | 0.8 | 2 | 0.5 | 3 | 0.993 | 40 | 35 | 2 | 2 | 1 | 1 | 1 | see monthly table | 0.2 | 0.25 | 5 | 0.85 | see monthly table |
| Well Drained Sand + Shrubland | | 0.3 | 2 | 0.5 | 0 | 0.995 | 40 | 35 | 2 | 2 | 1 | 1 | 1 | see monthly table | 0.2 | 0.25 | 5 | 0.998 | see monthly table |
| Well Drained Till + Annual Cropland | | 0.3 | 0.3 | 0.25 | 1.5 | 0.938-0.999 | 40 | 35 | 2 | 2 | 0-1 | 0.005-1 | 0.01-1 | see monthly table | 0.1 | 0.25 | 3.3 | 0.84-0.94 | see monthly table |
| Well Drained Till + Coniferous Forest | | 0.8 | 0.3 | 0.25 | 1.5 | 0.993-0.999 | 40 | 35 | 2 | 2 | 0-0.3 | 0.005 | 0.01 | see monthly table | 0.1 | 0.25 | 3.3 | 0.84 | see monthly table |
| Well Drained Till + Deciduous Forest | | 0.8 | 0.3 | 0.25 | 1.5 | 0.993-0.999 | 40 | 35 | 2 | 2 | 0-0.3 | 0.005 | 0.01 | see monthly table | 0.1 | 0.25 | 3.3 | 0.84-0.94 | see monthly table |
| Well Drained Till + Developed | | 0 | 0.3 | 0.25 | 1.5 | 0.993 | 40 | 35 | 2 | 2 | 1 | 1 | 1 | see monthly table | 0.1 | 0.25 | 3.3 | 0.84-0.94 | see monthly table |
| Well Drained Till + Exposed Land | | 0 | 0.3 | 0.25 | 1.5 | 0.999 | 40 | 35 | 2 | 2 | 0-0.3 | 0.005 | 0.01 | see monthly table | 0.1 | 0.25 | 3.3 | 0.84 | see monthly table |
| Well Drained Till + Grassland Native Grass | | 0.3 | 0.3 | 0.25 | 1.5 | 0.993-0.999 | 40 | 35 | 2 | 2 | 0-1 | 0.005-1 | 0.01-1 | see monthly table | 0.1 | 0.25 | 3.3 | 0.84 | see monthly table |
| Well Drained Till + Mixed Forest | | 0.5 | 0.3 | 0.008 | 5 | 0.993-0.999 | 40 | 35 | 2 | 2 | 0-0.3 | 0.005 | 0.01 | see monthly table | 0.1 | 0.75 | 3.3 | 0.84-0.94 | see monthly table |
| Well Drained Till + Perrenial Crops and Pasture | | 0.8 | 0.3 | 0.25 | 1.5 | 0.993-0.999 | 40 | 35 | 2 | 2 | 0-1 | 0.005-1 | 0.01-1 | see monthly table | 0.1 | 0.25 | 3.3 | 0.84-0.94 | see monthly table |
| Well Drained Till + Shrubland | | 0.3 | 0.3 | 0.25 | 1.5 | 0.993-0.999 | 40 | 35 | 2 | 2 | 0-1 | 0.005-1 | 0.01-1 | see monthly table | 0.1 | 0.25 | 3.3 | 0.84-0.94 | see monthly table |

**Monthly Interception**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Impervious + Coniferous Forest | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0.05 |
| Impervious + Deciduous Forest | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0.05 |
| Impervious + Exposed Land | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0.05 |
| Impervious + Grassland Native Grass | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0.05 |
| Impervious + Mixed Forest | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0.05 |
| Impervious + Shrubland | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0.05 |
| Well Drained Clay Loam + Annual Cropland | 0 | 0 | 0 | 0 | 0.05 | 0.1 | 0.05 | 0.35 | 0.4 | 0.4 | 0 | 0 |
| Well Drained Clay Loam + Developed | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Clay Loam + Exposed Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Clay Loam + Grassland Native Grass | 0.01 | 0.01 | 0.01 | 0.05 | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.05 | 0.01 |
| Well Drained Clay Loam + Perrenial Crops and Pasture | 1.8 | 1.5 | 1.2 | 0.4 | 0.05 | 0.1 | 0.05 | 0.35 | 0.4 | 0.4 | 0.4 | 1.5 |
| Well Drained Clay Loam + Shrubland | 1.8 | 1.5 | 1.2 | 0.4 | 0.05 | 0.1 | 0.05 | 0.35 | 0.4 | 0.4 | 0.4 | 1.5 |
| Well Drained Sand + Annual Cropland | 0 | 0 | 0 | 0 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0 |
| Well Drained Sand + Grassland Native Grass | 0.01 | 0.01 | 0.01 | 0.05 | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.05 | 0.01 |
| Well Drained Sand + Perrenial Crops and Pasture | 0 | 0 | 0 | 0 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0 |
| Well Drained Sand + Shrubland | 0.01 | 0.01 | 0.01 | 0.05 | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.05 | 0.01 |
| Well Drained Till + Annual Cropland | 0 | 0 | 0 | 0 | 0.05 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.05 | 0 |
| Well Drained Till + Coniferous Forest | 0.5 | 0.5 | 0.1 | 0.1 | 0.05 | 0.05 | 0.05 | 0.35 | 0.4 | 0.4 | 0.4 | 0.4 |
| Well Drained Till + Deciduous Forest | 0.5 | 0.5 | 0.1 | 0.1 | 0.05 | 0.05 | 0.05 | 0.35 | 0.4 | 0.4 | 0.4 | 0.4 |
| Well Drained Till + Developed | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Till + Exposed Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Till + Grassland Native Grass | 0.01 | 0.01 | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.05 | 0.01 |
| Well Drained Till + Mixed Forest | 0.5 | 0.5 | 0.1 | 0.1 | 0.05 | 0.05 | 0.05 | 0.35 | 0.4 | 0.4 | 0.4 | 0.4 |
| Well Drained Till + Perrenial Crops and Pasture | 0.5 | 0.5 | 0.1 | 0.1 | 0.05 | 0.05 | 0.05 | 0.35 | 0.4 | 0.4 | 0.4 | 0.4 |
| Well Drained Till + Shrubland | 0.01 | 0.01 | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.3 | 0.3 | 0.3 | 0.05 | 0.01 |

**Lower Zone Evapotranspiration**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Impervious + Coniferous Forest | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| Impervious + Deciduous Forest | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| Impervious + Exposed Land | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| Impervious + Grassland Native Grass | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| Impervious + Mixed Forest | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| Impervious + Shrubland | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| Well Drained Clay Loam + Annual Cropland | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.2 | 0.4 | 0.5 | 0.5 | 0 | 0 |
| Well Drained Clay Loam + Developed | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Clay Loam + Exposed Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Well Drained Clay Loam + Grassland Native Grass | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 |