LECTURE #11

NPS QUALITY (PQUAL, IQUAL) PROCESSES, PARAMETERS AND CALIBRATION

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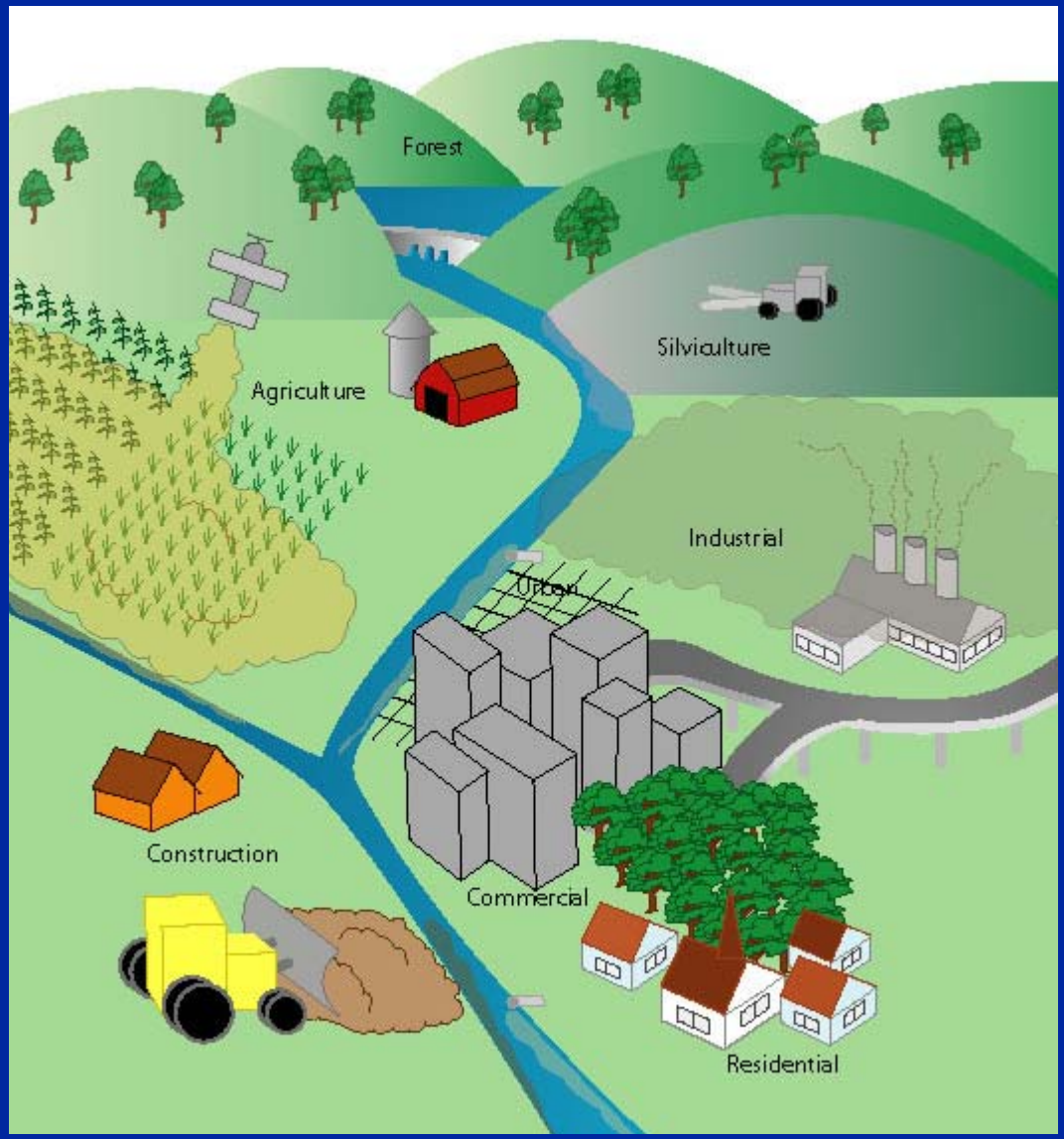
SOURCES OF NONPOINT POLLUTION



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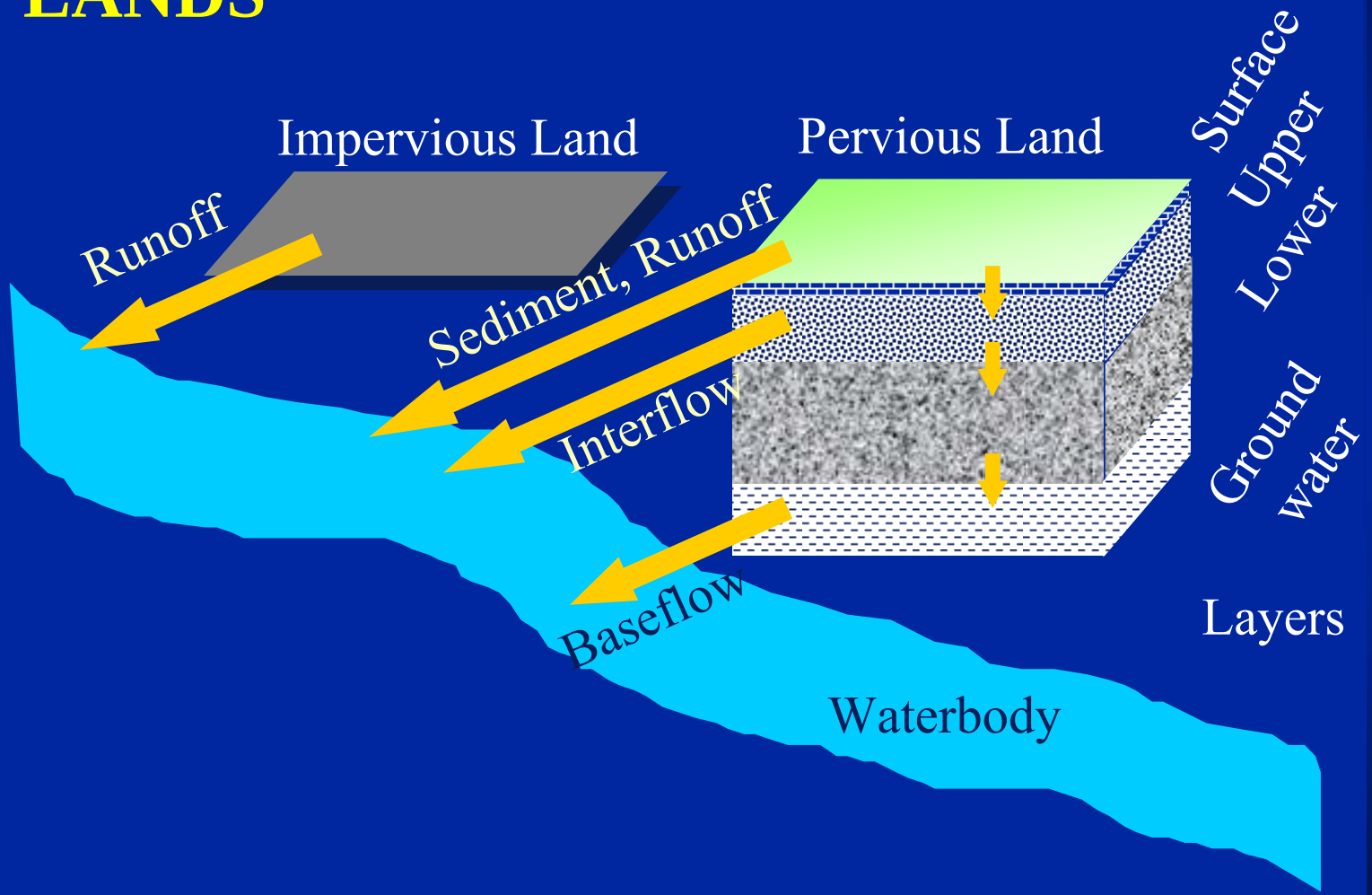
GENERATION OF CONSTITUENTS FROM PERVIOUS AND IMPERVIOUS LANDS



PERLND

Simulate a pervious land segment

ATEMP

Correct air temperature

SNOW

Simulate snow and ice

PWATER

Simulate water budget

SEDMNT

Simulate sediment

PSTEMP

Estimate soil temperature(s)

PWTGAS

Estimate water temperature and gas concentrations

PQUAL

Simulate general quality constituents

MSTLAY

Estimate solute transport

PEST

Simulate pesticides

NITR

Simulate nitrogen

PHOS

Simulate phosphorus

TRACER

Simulate a conserv. tracer

PERLND STRUCTURE CHART

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PERLND/IMPLND QUALITY PROCESSES AND MODULES

Module	Process
PQUAL, IQUAL	General (User-Specified) Pollutant Accumulation and Washoff
PWTGAS, IWTGAS	Dissolved Gas Washoff
MSTLAY	Moisture Movement and Washoff
PEST	Pesticide Sorption, Decay, and Fate
NITR	Nitrogen Transformations and Fate
PHOS	Phosphorus Transformations and Fate

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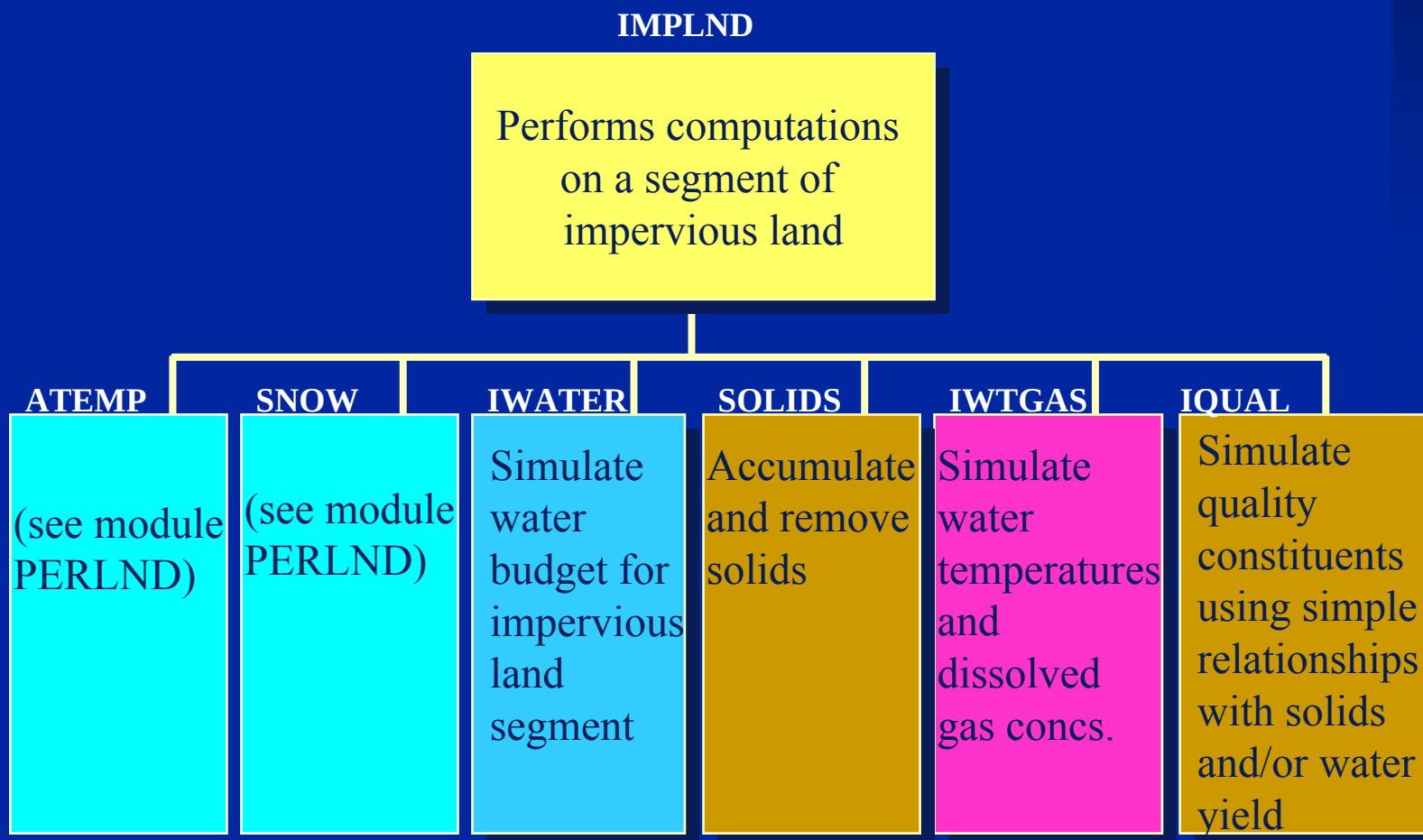
IMPLND STRUCTURE CHART



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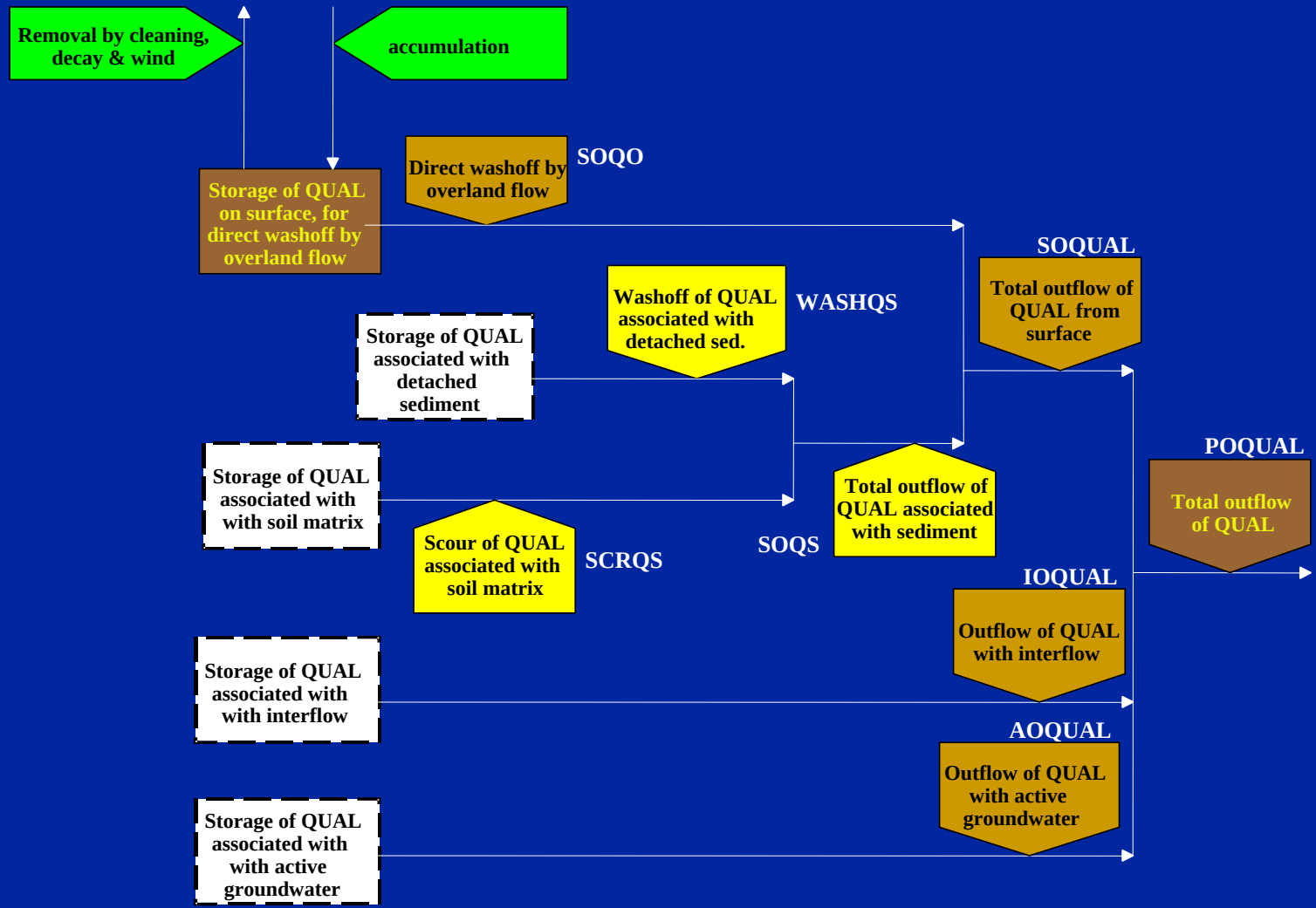
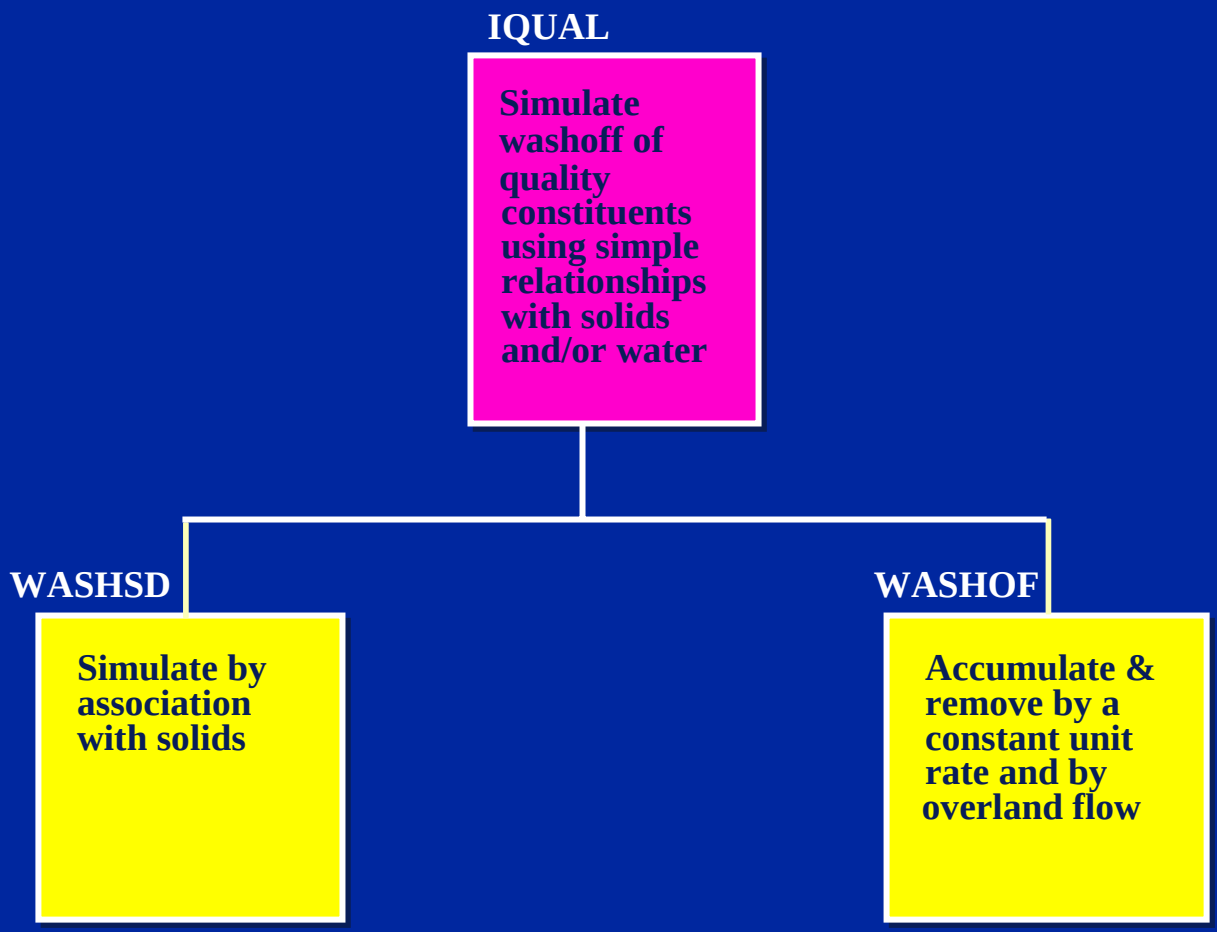
PQUAL FLOW DIAGRAM



IQUAL STRUCTURE CHART



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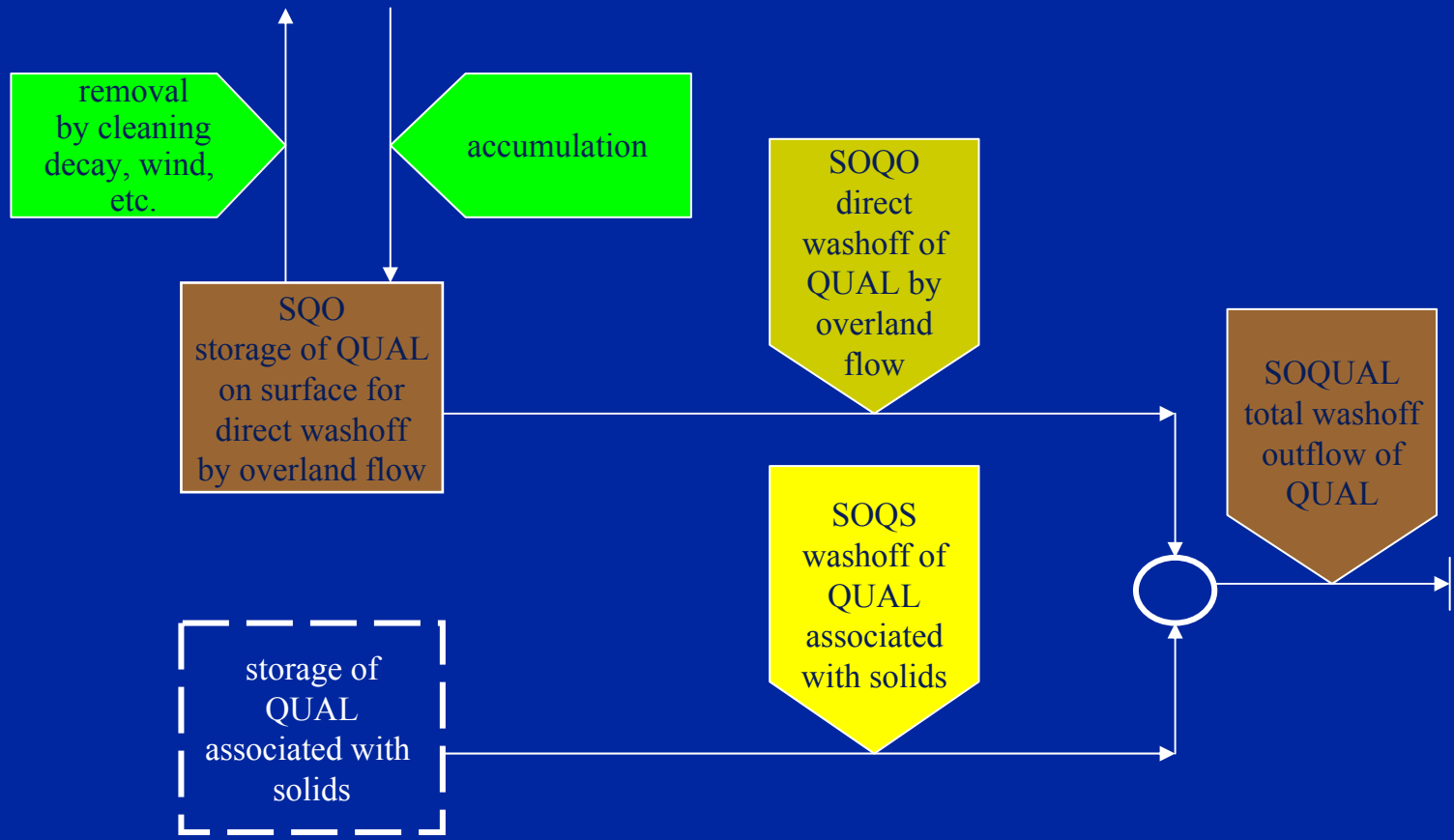
IQUAL FLOW DIAGRAM



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OVERLAND GENERAL QUALITY - BUILDUP

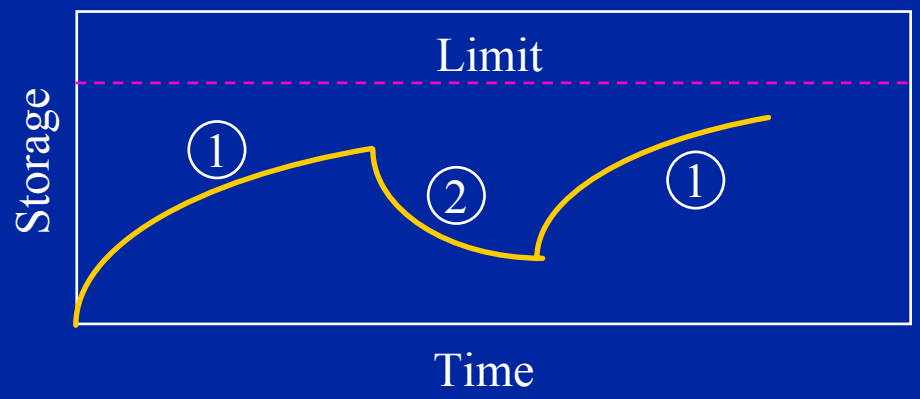
- **Build-up**
- Washoff

Constituent Build-up

- Accumulation at a constant rate for the constituent not attached to the sediment.
- Computed at daily time interval
- Build-up is not calculated for sediment associated portion since an unlimited supply of sediment is assumed

① Build up

② Washoff



Change of storage with time

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OVERLAND GENERAL QUALITY - WASHOFF

- Build-up
- **Washoff**

Constituent removal from pervious land

Processes independent of sediment washoff

- by overland flow
- by processes independent of storm events, i.e. cleaning, decay, wind erosion

Sediment associated

- associated with sediment/solids washoff
- associated with sediment scour

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TYPES OF CONSTITUENTS SIMULATED BY PQUAL/IQUAL

Identity	Simulation Method	Input Parameters
QUALSD	Associated with Sediment Washoff	POTFW
	Associated with Sediment Scour	POTFS
QUALOF	Daily Accumulation and Washoff by Overland Flow	ACQOP SQOLIM WSQOP
QUALIF	Associated with Interflow (PQUAL Only)	IOQC
QUALGW	Associated with Groundwater Flow (PQUAL Only)	AOQC

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QUALOF SIMULATION WITH PQUAL/IQUAL

Accumulation:

SQO = ACQOP + SQOS * (1.0 - REMQOP)

Where:

REMQOP = ACQOP/SQOLIM

Washoff:

SOQO = SQO * (1.0 - EXP(-SURO * WSFAC))

Where:

WSFAC = 2.3/WSQOP

Input Parameters

ACQOP
SQOLIM
WSQOP

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PQUAL/IQUAL CALIBRATION PROCEDURES

- For sediment-associated pollutants, adjust relevant Potency Factors (POTFW, POTFS)
- For overland pollutants,
  - Reduce SQOLIM if too much washoff for all storms, and vice versa
  - Increase WSQOP if too much washoff for small storms only, and vice versa
  - Reduce ACQOP if too much washoff for closely-spaced storms only, and vice versa
- For interflow and groundwater pollutants, adjust for IOQC and AOQC, respectively, for appropriate time period.

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PERVIOUS PQUAL PARAMETER VALUES FROM THE PATUXENT STUDY

LAND USE	NO_3	NH_4	PO_4	BOD
POTENCY FACTORS (LB/TON)				
Low density resid.	0.75	0.2	0.55	45.
Unsewered low density	0.75	0.2	0.55	45.
Med/high density resid.	3.0	1.0	0.8	90.
Commercial/industrial	5.0	1.6	1.35	135.
Forest and Wetland	0.05 - 0.09	0.0055 - 0.0095	0.02 - 0.035	5.5 - 8.5
Pasture	1.8	0.2	0.135	30.
Idle agricultural land	1.0	0.1	0.08	15.
SUBSURFACE CONCENTRATIONS (MG/L)				
Low density resid.	0.65 - 1.1*	0.03	0.025, 0.002 **	1.3
Unsewered low density	1.3 - 2.2	0.06	0.025, 0.002	1.3
Med/high density resid.	1.9 - 2.6	0.06	0.04, 0.004	2.0
Commercial/industrial	2.9 - 3.9	0.08	0.055, 0.005	2.7
Forest and Wetland	0.65 - 0.85	0.02	0.005, 0.001	0.25
Pasture	1.2 - 1.6	0.025	0.015, 0.001	0.7
Idle agricultural land	0.8 - 1.05	0.015	0.01, 0.001	0.4

* - seasonal range
** - first value is interflow, second value is groundwater

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IMPERVIOUS IQUAL PARAMETER VALUES FROM THE PATUXENT STUDY

LAND USE	NO_3	NH_4	PO_4	BOD
	ACCUMULATION RATES (lb/ac/day) - **ACQOP**			
Low density resid.	0.005	0.01	0.002	0.2
Med/high density resid.	0.02	0.05	0.003	0.4
Commercial/industrial	0.04	0.08	0.005	0.6
Roads	0.002	0.005	0.001	0.1
	ACCUMULATION LIMIT (lb/ac) - **SQOLIM**			
All Land Uses	0.25	0.07	0.03	7.5
	WASHOFF FACTOR (in/hr) - **WSQOP**			
All Land Uses	0.50	0.50	0.50	0.50
	CALCULATED REMOVAL RATES (/day)*			
Low density resid.	0.02	0.14	0.067	0.027
Med/high density resid.	0.08	0.71	0.10	0.053
Commercial/industrial	0.16	1.1	0.17	0.080
Roads	0.008	0.071	0.033	0.013
	CALCULATED ACCUMULATION LIMIT IN DAYS (days)**			
Low density resid.	50.0	7.1	14.9	37.0
Med/high density resid.	12.5	1.4	10.0	18.9
Commercial/industrial	6.2	0.9	5.9	12.5
Roads	125.0	14.1	30.3	76.9

* - REMOVAL RATE = ACQOP/SQOLIM
** - LIMIT, days = SQOLIM/ACQOP

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PSTEMP (SOIL TEMPERATURE) SIMULATION - SURFACE LAYER

SURFACE LAYER- linear regression with air temperature

$$SLTMP = ASLT + BSLT * AIRTC$$

where:

SLTMP	=	surface layer temperature, °C
ASLT	=	Y - intercept
BSLT	=	slope
AIRTC	=	air temperature, °C

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PSTEMP (SOIL TEMPERATURE) SIMULATION - SUBSURFACE LAYER, TSOPFG=1

SUBSURFACE LAYERS - Two Options

TSOPFG = 1

UPPER ZONE LAYER -

- Linear regression with air temperature
- Same equation as for surface layer with different parameters for the upper soil zone

LOWER/GROUNDWATER LAYERS -

- User-defined annual or monthly values
- Same values for both Lower Zone and Groundwater Zone

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PSTEMP (SOIL TEMPERATURE) SIMULATION - SUBSURFACE LAYER, TSOPFG=0

SUBSURFACE LAYERS - Two Options

TSOPFG = 0

- Mean departure from air temperature plus smoothing factor
- Same equation used for Upper Zone and Lower/Groundwater Zone, with different parameters
- Same values for both Lower Zone and Groundwater Zone

$$TMP = TMPS + SMO * (AIRTCS + TDIF - TMPS)$$

where:

TMP	=	soil layer temperature for current interval, ^oC
TMPS	=	soil layer temperature for previous interval, ^oC
SMO	=	smoothing factor (user-defined parameter)
AIRTCS	=	air temperature during current interval, ^oC
TDIF	=	mean difference between air and soil temperatures, ^oC (user-defined parameter)

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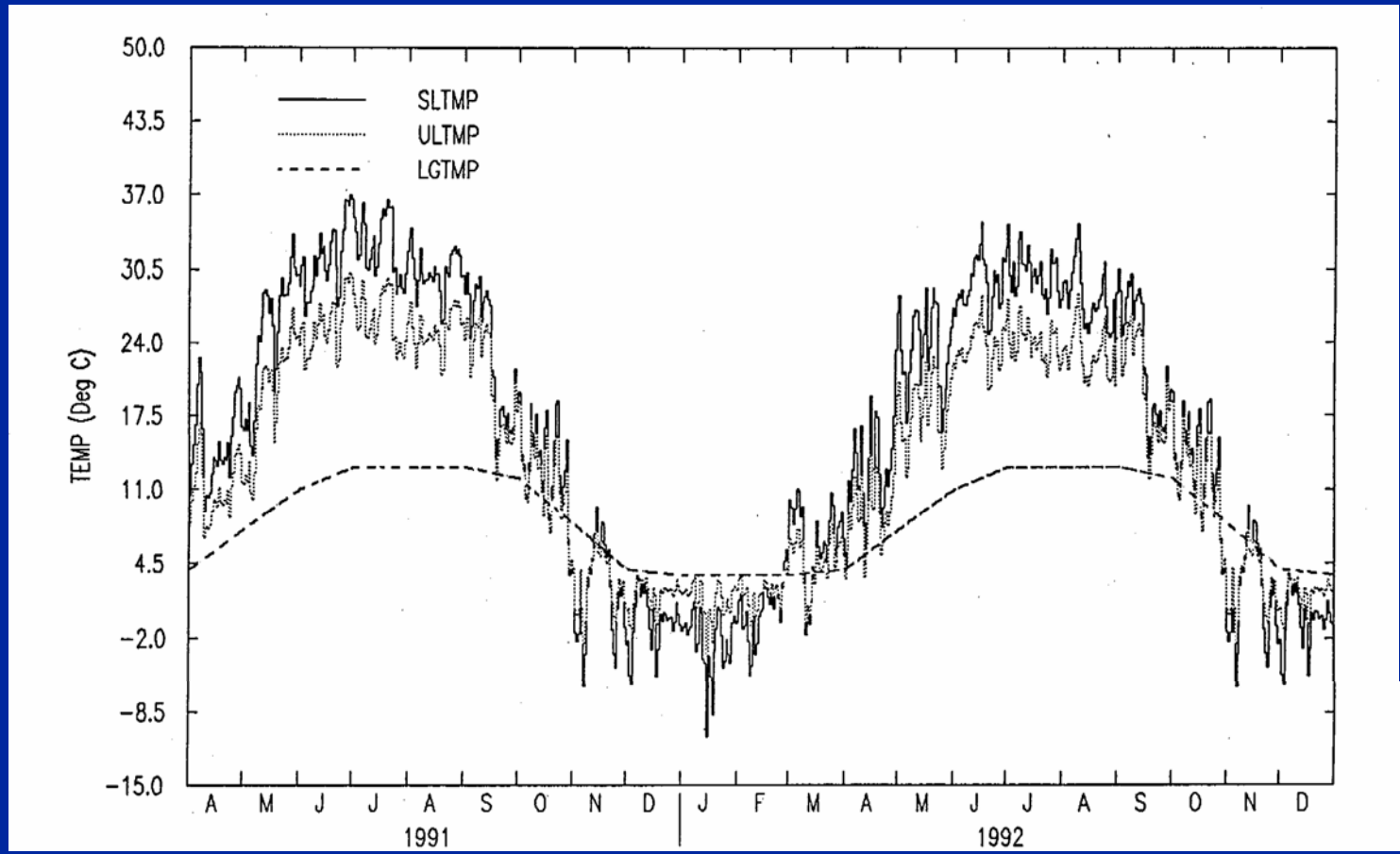
SOIL TEMPERATURE RESULTS FOR WALNUT CREEK, IA



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PWTGAS/IWTGAS SIMULATION AND CALIBRATION

1. Estimate All Dissolved Gas Parameters

   PWTGAS - ELEV, IDOXP, ICO2P, ADOXP, ACO2P
   IWTGAS - ELEV, AWTF, BWTF

   ELEV - Model Segment Elevation
   IDOXP & ICO2P - Interflow Concentrations
   ADOXP & ACO2P - Baseflow Concentrations
   AWTF & BWTF - Regression Parameters for Impervious Surface Runoff Temperature

2. Adjust Temperatures (Simulated or Input) to Modify Gas Saturation Concentrations in Overland Flow

3. For PWTGAS, Adjust Interflow and Groundwater Gas Concentrations, if necessary

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