



BENGAWAN SOLO RIVER BASIN MANAGEMENT (POLA & RENCANA)

Possible Strategies for Climate Change Adaptation

Dwl Agus Kuncoro

(Head of General Planning and Program Division)

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01

Overview of Bengawan Solo River Basin

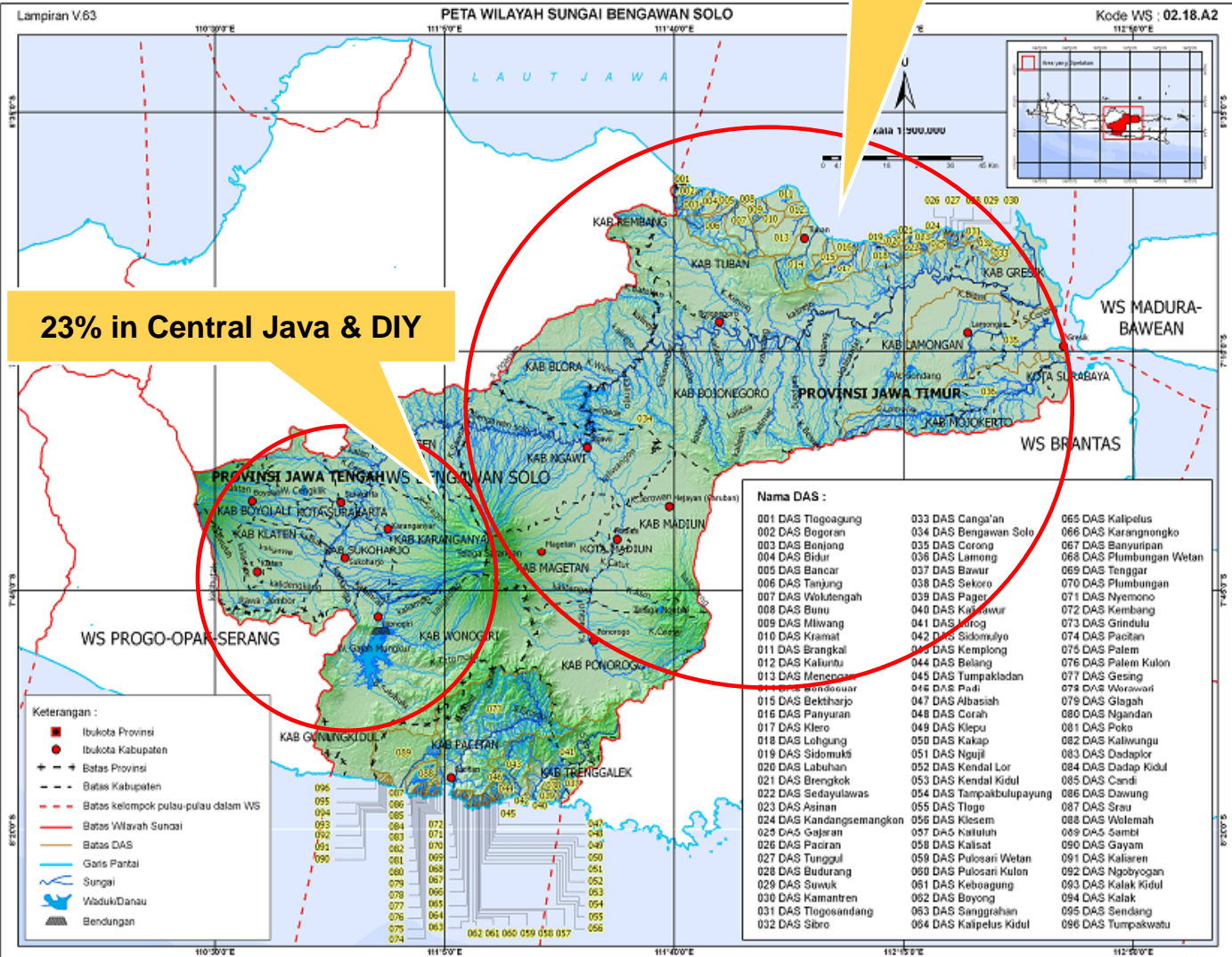
Gambaran Wilayah Sungai Bengawan Solo

MAP OF BENGAWAN SOLO RIVER BASIN



77% in East Java

23% in Central Java & DIY

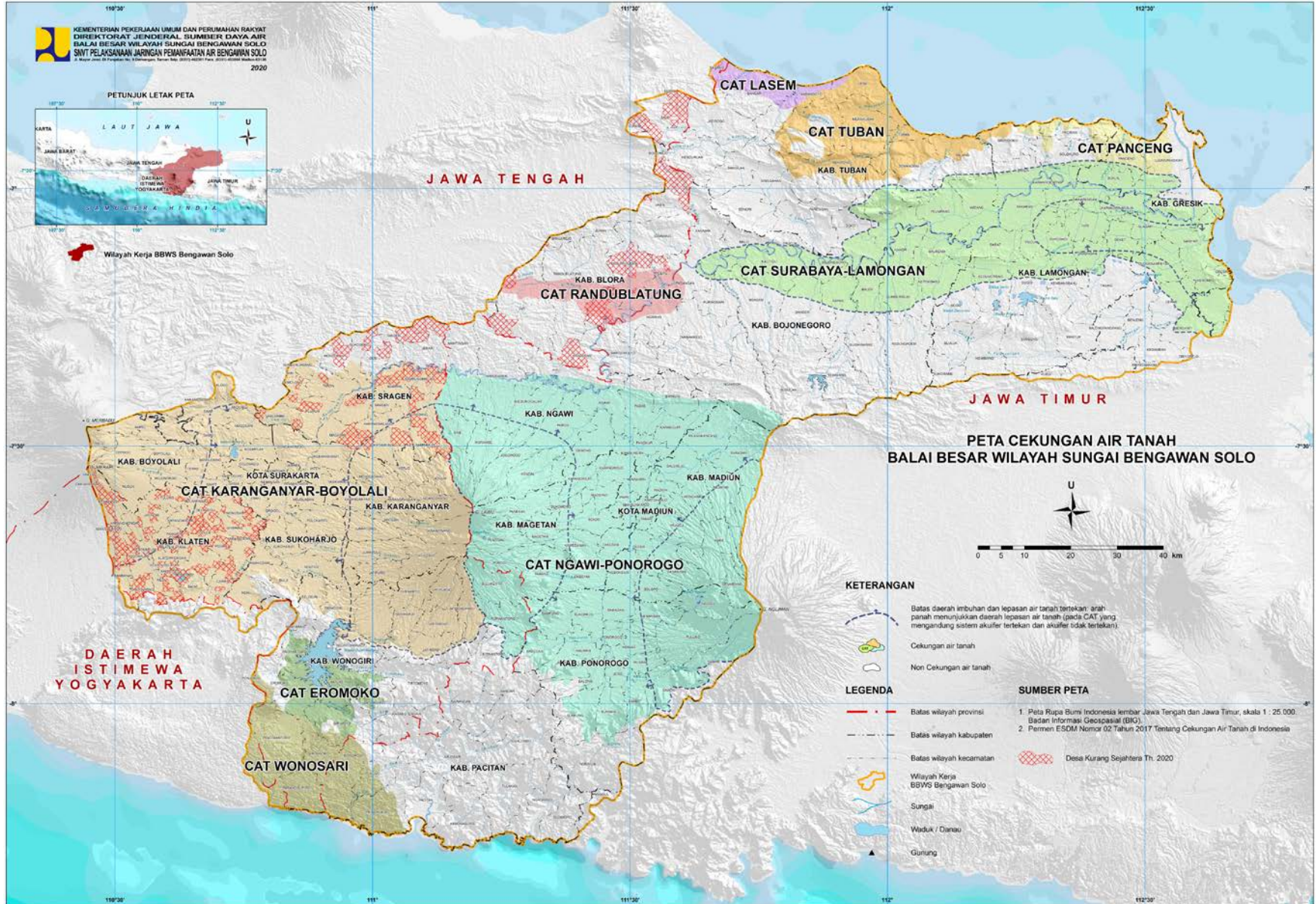


- Largest river basin in Java Island / Wilayah Sungai terluas di Pulau Jawa
- Basin Area / Luas Wilayah Sungai : ± **19.778 km²** (12% of Java Island)
- Length / Panjang Sungai : ± **600 km**
- 3 Main Watersheds / 3 DAS Utama :
 - Bengawan Solo
 - Corong
 - Lamong
- The river flow through / Wilayah Administratif :
 - 3 Provinces / Provinsi
 - 20 Districts / Kabupaten
 - 3 Cities / Kota
- **Geomorphologically not ideal**
 - 70 % Plain/ Dataran
 - 30 % Highland/ Dataran tinggi

GROUNDWATER BASIN / CEKUNGAN AIR TANAH



KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL SUMBER DAYA AIR
BALAI BESAR WILAYAH SUNGAI BENGAWAN SOLO



9 Groundwater Basins / Terdapat 9 Cekungan Air Tanah di WS Bengawan Solo ⁴



Issues related to Climate Change **Isu terkait Perubahan Iklim**

- *Extreme Rainfall / Curah Hujan Ekstrem*
- *Severe Drought / Kekeringan Parah*
- *Increased occurrence of Sheet Erosion / Erosi Lembaran meningkat*
- *Increased occurrence of Landslide / Tanah longsor meningkat*
- *Increased rate of Sedimentation / Sedimentasi meningkat*
- *Increasing Flood Areas / Meluasnya area genangan banjir*

Non Groundwater Basins Area are vulnerable to experience the above issues
Area non CAT rentan mengalami berbagai isu diatas



02

Flood Management of Bengawan Solo River Basin

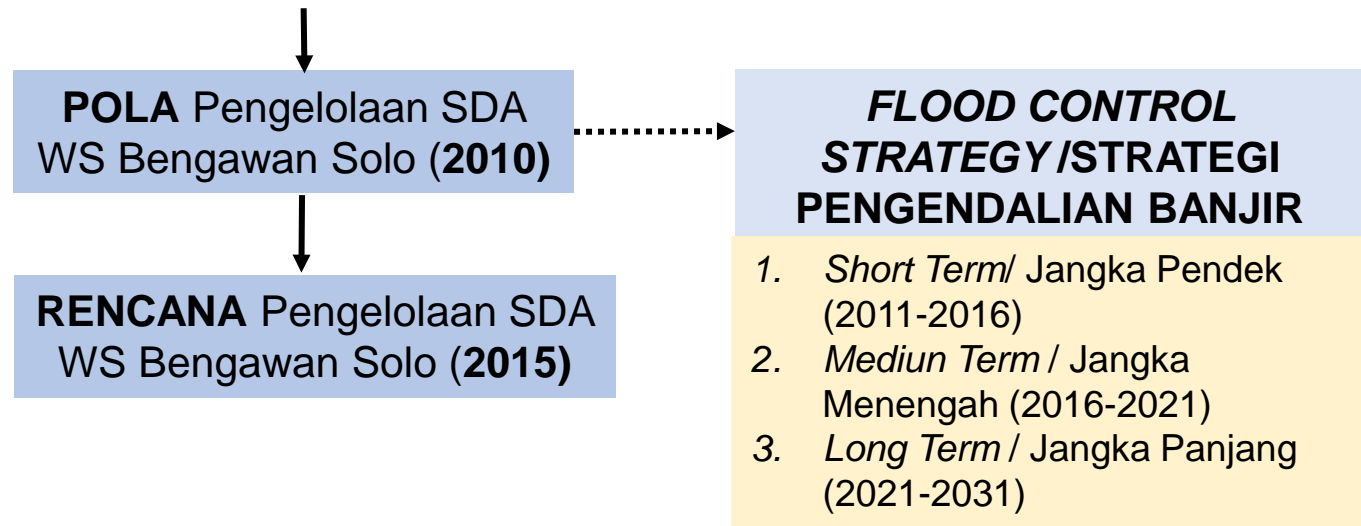
Pengelolaan Banjir Wilayah Sungai Bengawan Solo



History of Bengawan Solo Flood Management

Sejarah Rencana Pengelolaan Banjir Sungai Bengawan Solo

- Master Plan Tahun 1974 – Overseas Technical Cooperation Agency (OCTA)
- Comprehensive Development Management Plan (CDMP), 2001
- Lower Solo River Improvement Project (LSRIP) Phase I (1990an-2000-an)
- Lower Solo River Improvement Project (LSRIP) Phase II (2009-2015)
→ Jabung Ring Dyke, Bojonegoro Barrage





Flood Management Strategies

Strategi Pengendalian Banjir



STRUCTURAL MEASURES / UPAYA FISIK



DAM
bendungan

BARRAGE
Bendung Gerak

DIKES
Tanggul



NON-STRUCTURAL MEASURES / UPAYA NON - FISIK

EARLY WARNING SYSTEM (EWS) / Peringatan Dini

1. **TELEMETRY**
2. **COMMUNITY - BASED**

FLOOD FORECASTING WARNING SYSTEM / SISTEM PERKIRAAN BANJIR

COMMUNITY ENGAGEMENT / KETERLIBATAN MASYARAKAT

Structural Measures Upaya Fisik

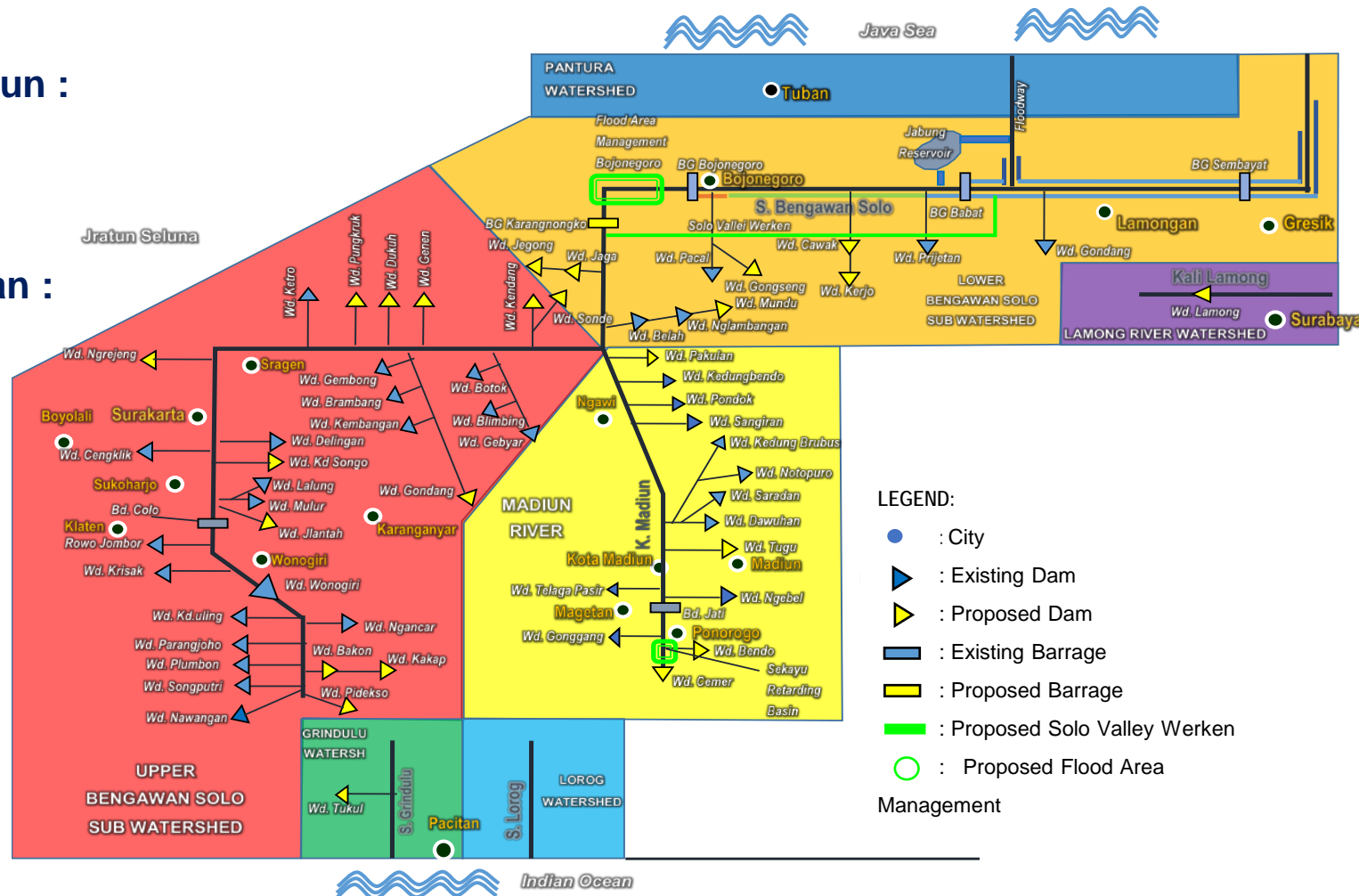


Existing / Telah terbangun :

- 34 Dams
- 3 Barrages
- ± 113 Km Dikes

Proposed / Direncanakan :

- 18 Dams
- Karangnongko
- Dikes
- Solo Valley Werken



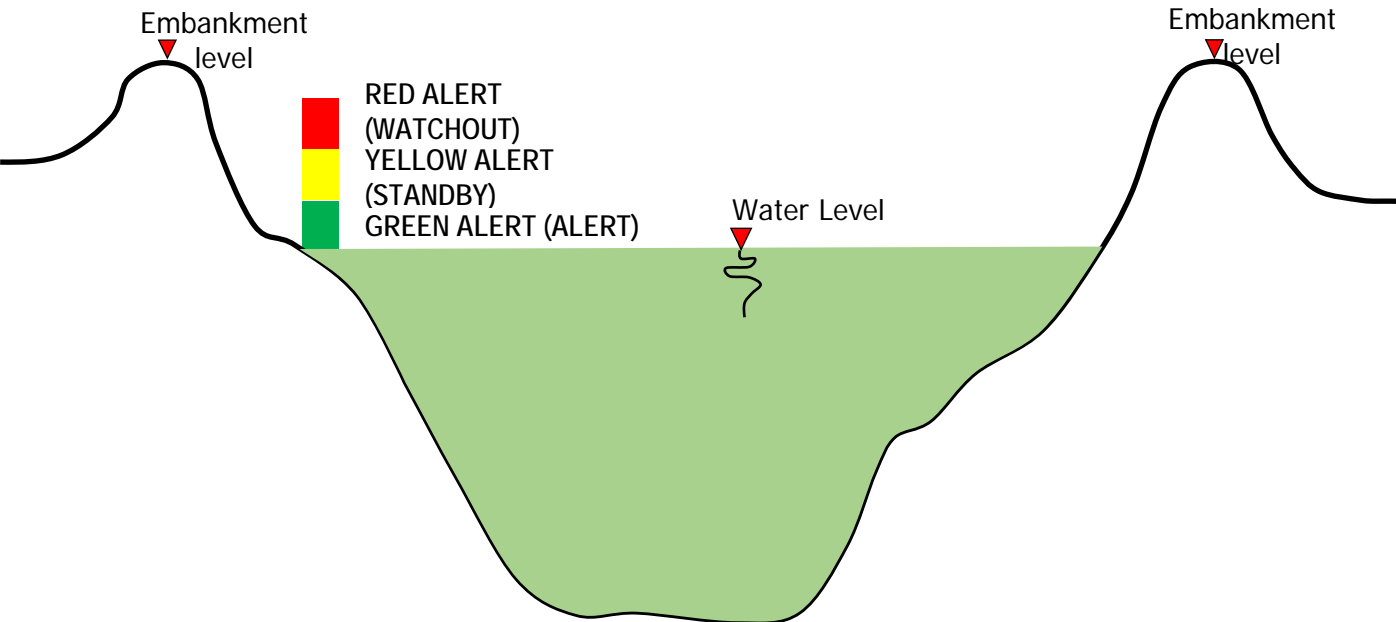
LEGEND:

- : City
- ▶ : Existing Dam
- ▶ : Proposed Dam
- ▭ : Existing Barrage
- ▭ : Proposed Barrage
- ▬ : Proposed Solo Valley Werken
- : Proposed Flood Area Management

**BENGAWAN SOLO FLOOD CONTROL SCHEME
SKEMA PENGENDALIAN BANJIR BENGAWAN SOLO**

Water Level Monitoring

Monitoring Tinggi Muka Air



DANGER LEVEL	FREEBOARD (M)	WATER LEVEL OBSERVATION
Green Alert	1,25 – 1,50	every 2 hour
Yellow Alert	0,75 – 1,25	every 1 hour
Red Alert	0,50 – 0,75	continously

Hydrological Information System

Sistem Informasi Hidrologi



KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
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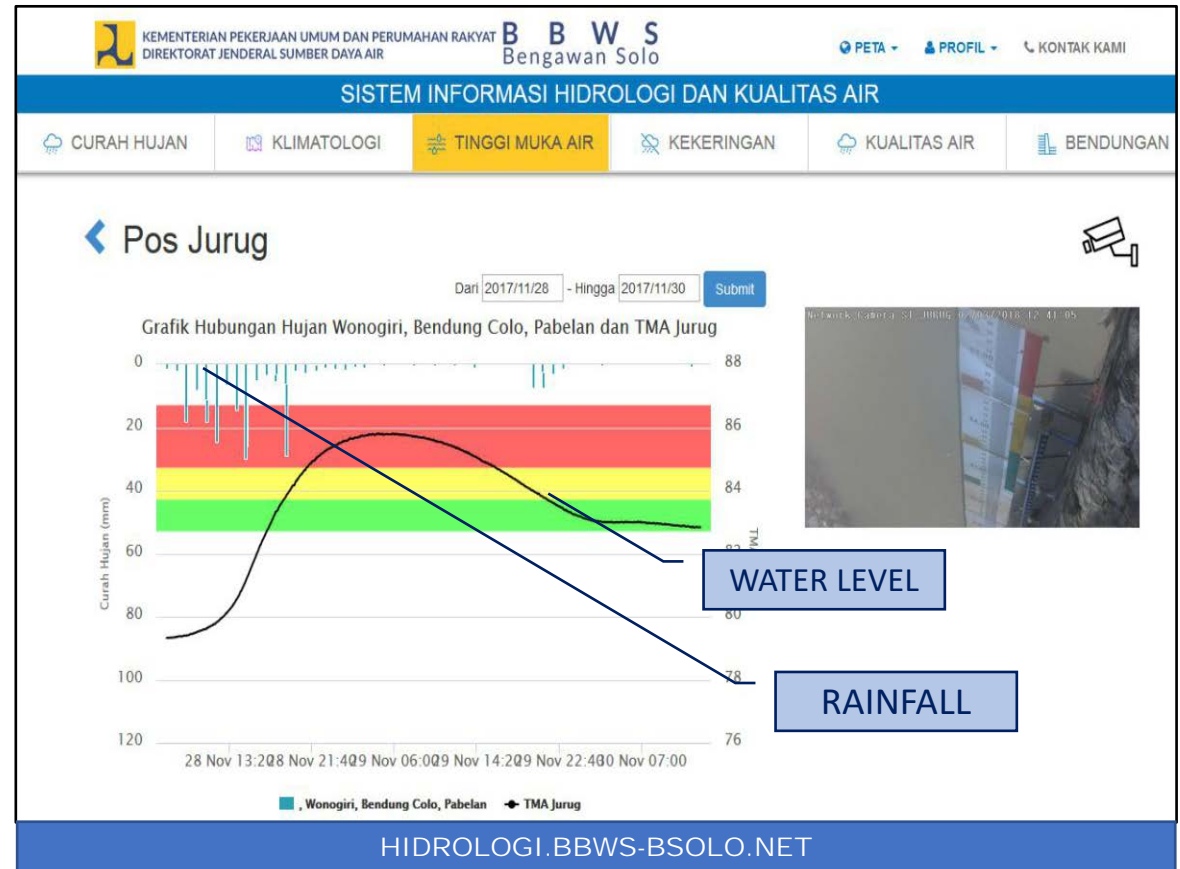
39 AWLR



64 ARR



7 CLIMATE STATIONS

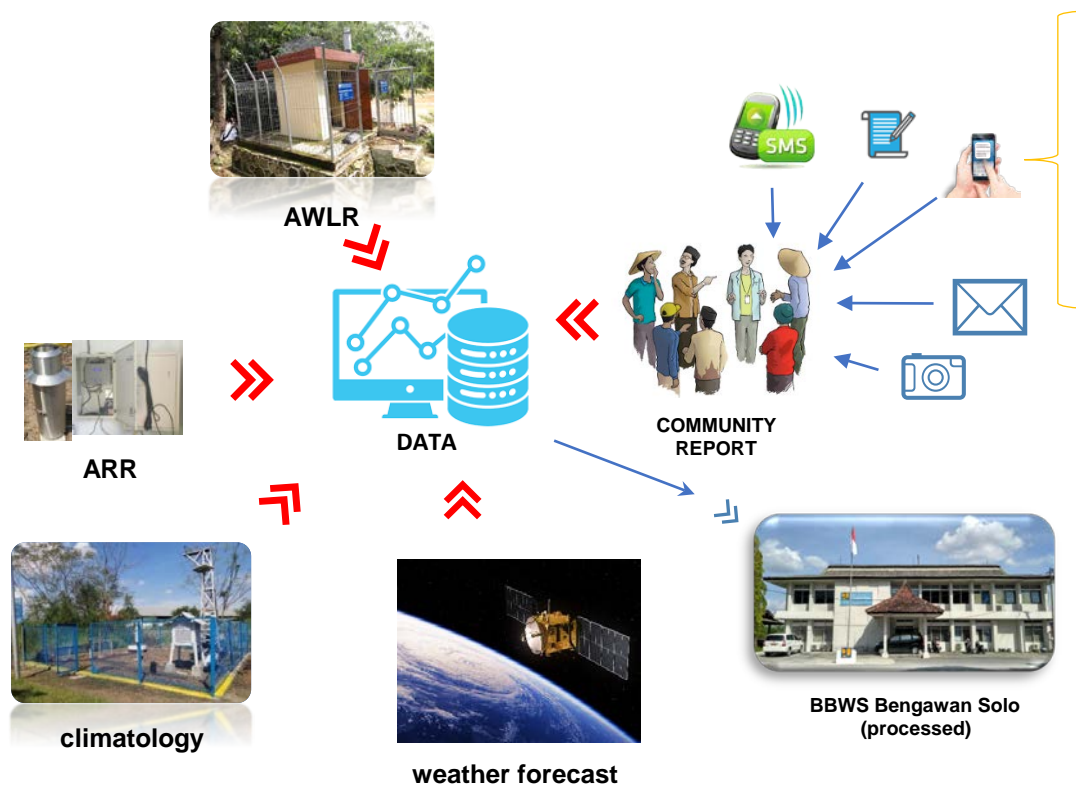


Non-Structural Measures

Upaya Non Fisik



COMMUNITY-BASED EARLY WARNING SYSTEM (EWS)



Non-Structural Measures

Upaya Non Fisik



KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL SUMBER DAYA AIR
BALAI BESAR WILAYAH SUNGAI BENGAWAN SOLO

PEPE RIVER, SURAKARTA



DENGKENG RIVER, KLATEN



COMMUNITY ENGAGEMENT FOR CLEANING UP RIVER
Pelibatan masyarakat dengan kegiatan bersih-bersih sungai



03 *Adaptation Strategy*

Strategi Adaptasi



Conservation Strategy – Bengawan Tactic

Strategi Konservasi – Taktik Bengawan

OFF STREAM

Reforestation in Catchment areas (offstream) are performed in 4 steps :

Pola reboisasi di *catchment area* akan dilakukan melalui 4 langkah:

- 1. Choose plants with taproots and or adventitious roots, avoid plants with fibrous roots***
Pilih tanaman berakar tunggang dan atau tunjang, hindari tanaman berakar serabut.
- 2. Check elevation of the location, find the right plants that can live at the elevation.***
Lihat elevasi lokasi yang ada, cari tanaman yang sesuai untuk hidup dielevasi dan point 1.
- 3. Analyse type of soils in the location, find the right plants that can live with the kind of soil.***
Lihat jenis tanah yg ada di lokasi tsb, cari tanaman yg sesuai utk hidup dg jenis tanah tsb & point 1 & 2.
- 4. Choose plants with economic value, but the harvesting method does not kill the plant.***
Pilih tanaman mempunyai nilai ekonomi tapi cara panennya tdk membunuh tanaman tsb.

taproot



fibrous roots



adventitious roots



Type of roots → elevation → type of soils → harvesting method
Type Akar → elevasi → jenis tanah → metode panen



Sediment Pocket Under Water/ SPUW

IN STREAM

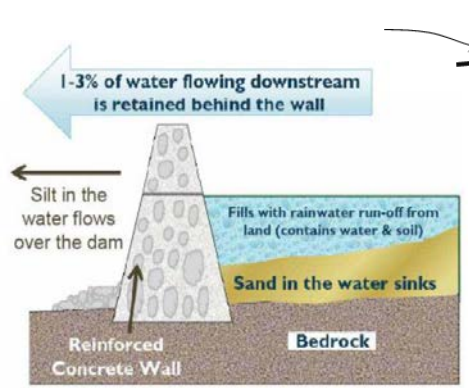
*Water reservoir design should be reviewed to become **a reservoir which is adaptive to sedimentation**. Outlet should be kept away from spillway and plan to construct Sediment Pocket Under Water/ SPUW at the river mouth with sediment from the reservoir (sediment will be dredged during periodic maintenance (once every 2 to 5 years).*

Desain tampungan air direview utk menjadi tampungan air yg adaptif terhadap sedimentasi. (Tata letak outlet dijauhkan dari spillway dan rencana pembuatan Sediment Pocket Under Water/SPUW di muara sungai dg kolam waduk, yg akan didreging sediment dg keg pemeliharaan berkala waduk (2-5 th sekali).

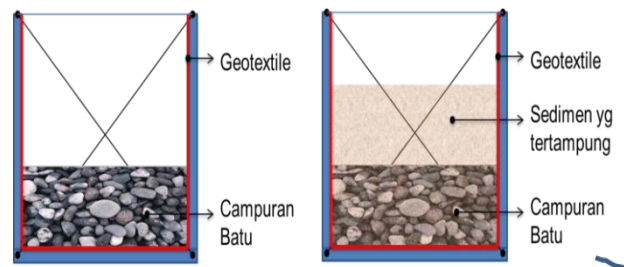
Sediment Pocket Under Water

SPUW

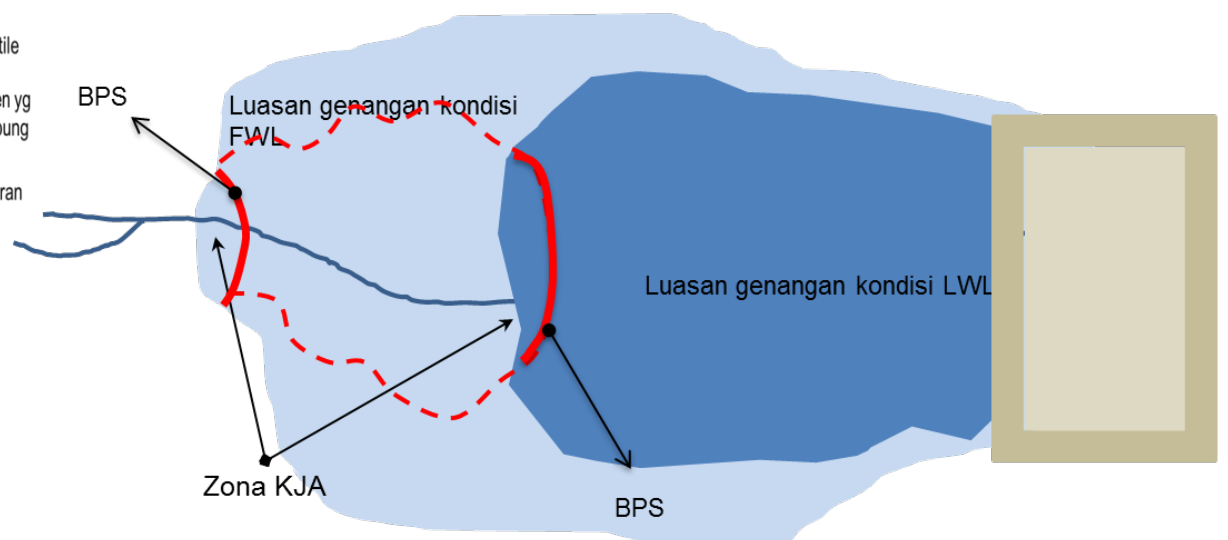
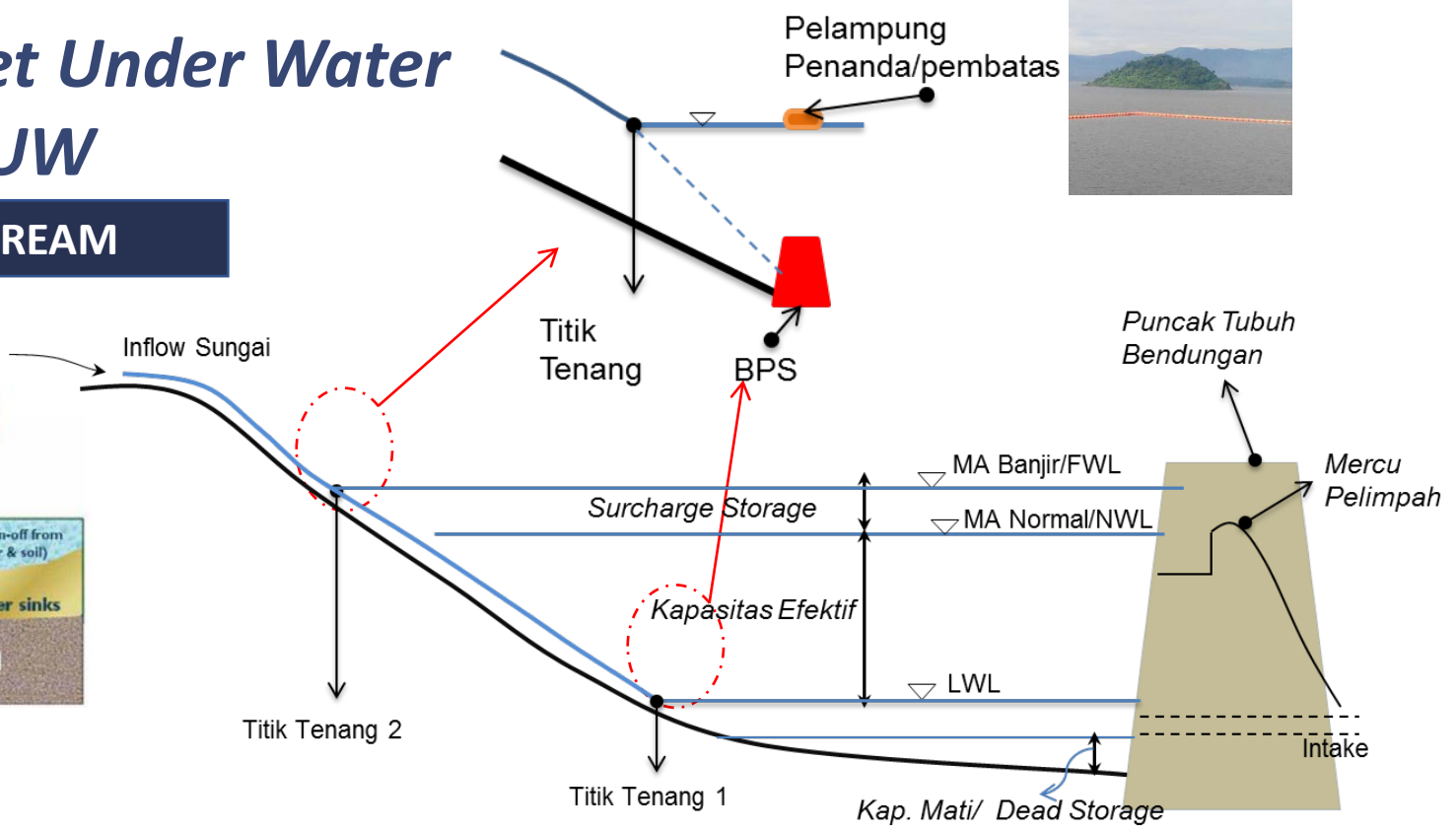
IN STREAM



Konstruksi Groundsil



Konstruksi SUPW





Embankment Strengthening - “SUPW” Concept **SUPW - Sistem Urug dengan Perkuatan Wadah**

IN STREAM

Build embankment with “SUPW” concept (“two feet embankment”)

Membuat tanggul 2 kaki dengan teknologi SUPW (Sistem Urug Perkuatan Wadah).

Benefits of SUPW :

Keuntungan SUPW :

- *Elevate the embankment / Meninggikan Tanggul*
- *River Normalization / Normalisasi Sungai*
- *The embankment can withstand overtopping*
Tanggul akan tahan terhadap overtopping

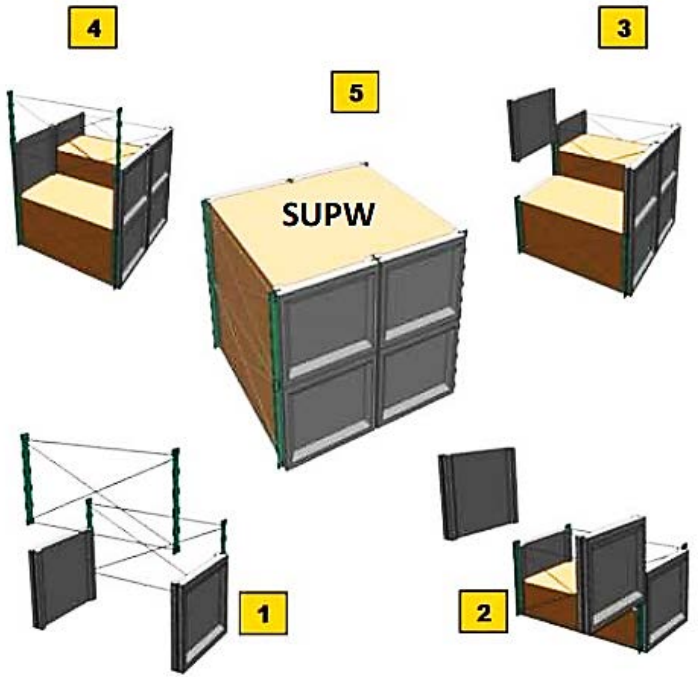




Embankment Strengthening - "SUPW" Concept

SUPW - Sistem Urug dengan Perkuatan Wadah

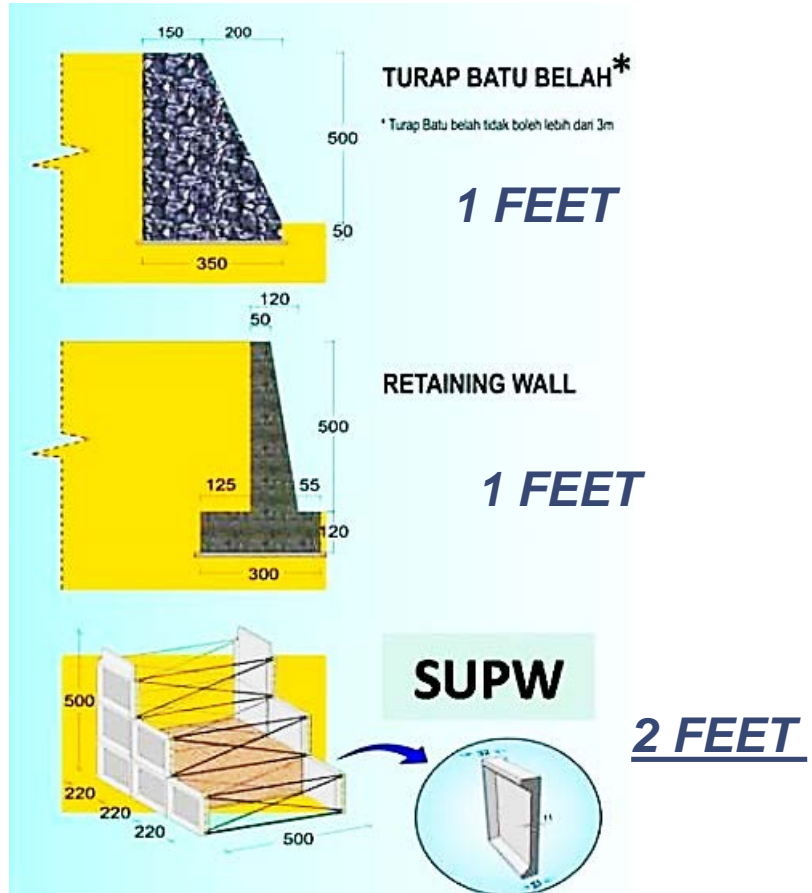
IN STREAM



SUPW Installment
Pemasangan SUPW



Force philosophy
"pencak silat"

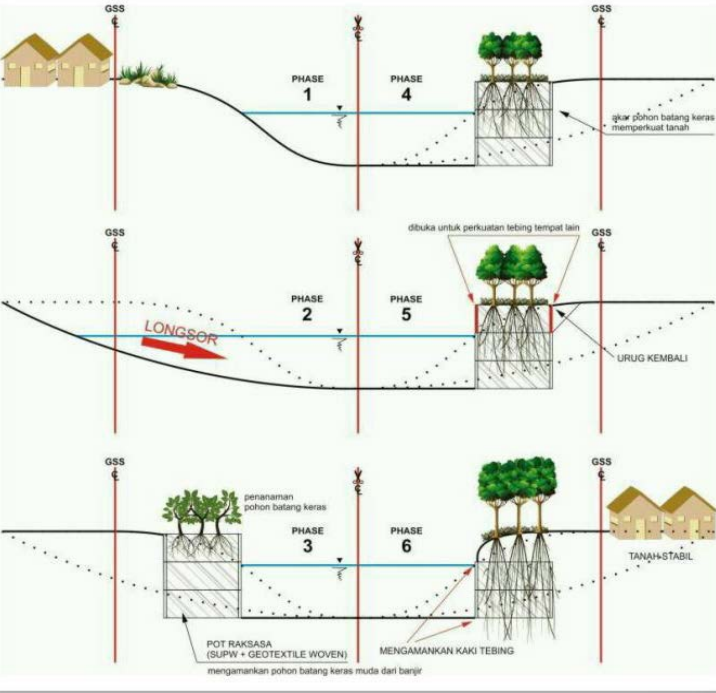


Comparison of SUPW with traditional embankment strengthening method
Perbandingan SUPW dg Perkuatan Tebing Konvensional 19

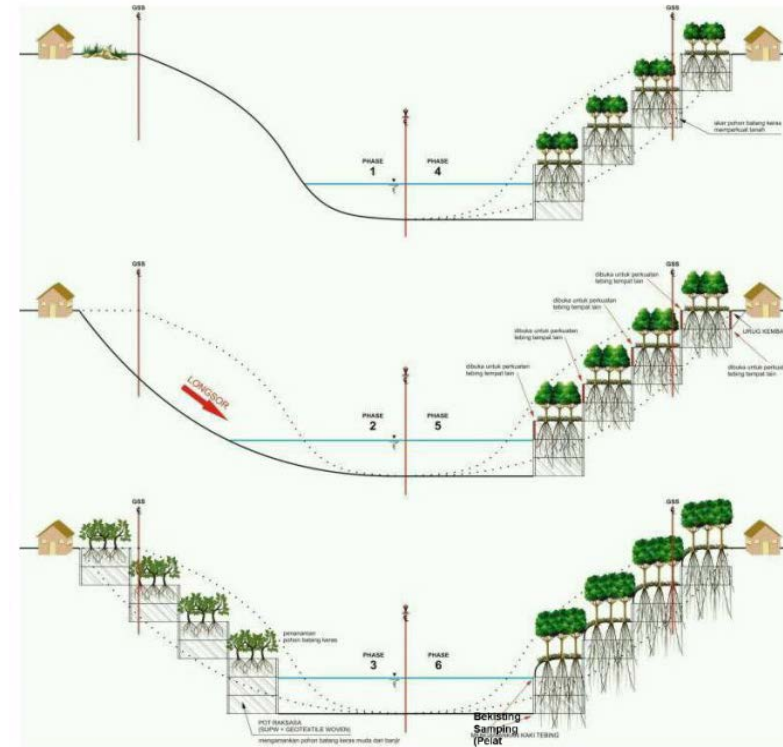
SUPW "PANEL RAKYAT" KNOCK-DOWN SYSTEM



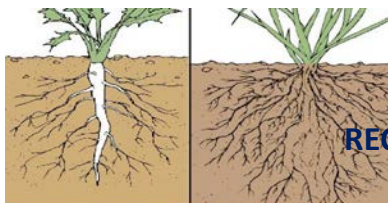
IN STREAM



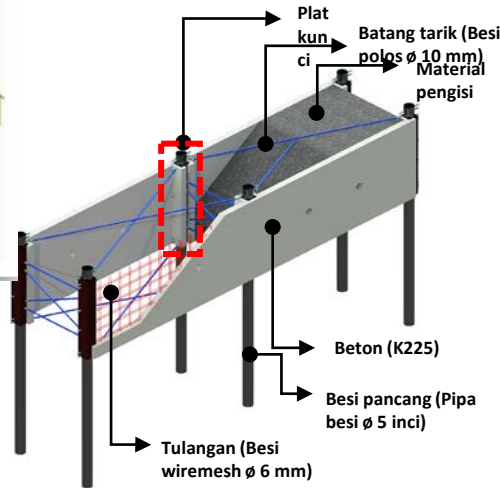
**CASE 1
 NARROW
 AREA**



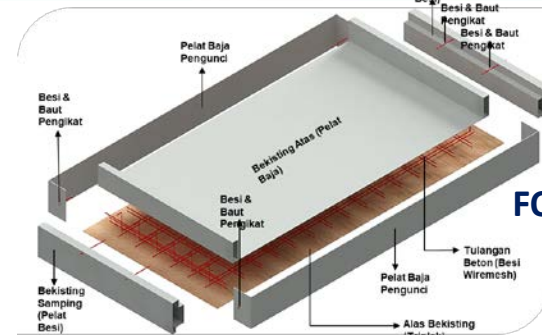
**CASE 2
 WIDE
 AREA**



**NOT
 RECOMMENDED**



PILE



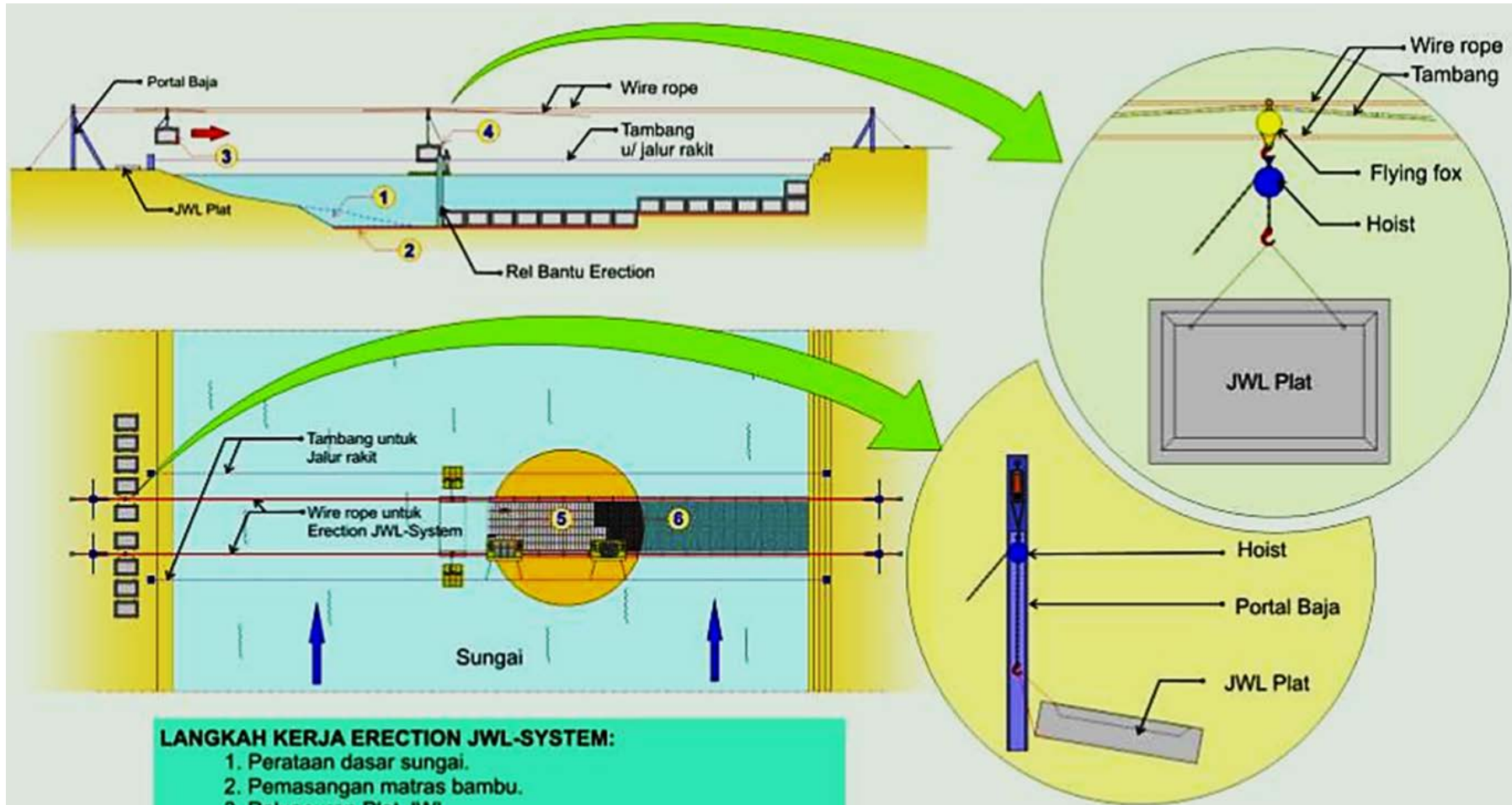
FORMWORK

SUPW Installment Procedure

Metode Kerja Pemasangan SUPW



IN STREAM



LANGKAH KERJA ERECTION JWL-SYSTEM:

1. Perataan dasar sungai.
2. Pemasangan matras bambu.
3. Peluncuran Plat JWL.
4. Penurunan Plat JWL ke posisi dasar sungai.
 - Pemasangan Plat Penyambung.
 - Pemasangan Batang Tarik.
 - Grouting.
5. pengisian JWL-System dengan material dasar sungai.
6. Pemasangan brongjong diatas JWL-System.

NO DEWATERING

RAINWATER HARVESTING PEMANENAN AIR HUJAN



OFF STREAM



**RAINWATER HARVESTING PROJECTS
IN BENGAWAN SOLO RIVER BASIN**

NO	LOCATION	NUMBER
1	Klaten	7
2	Boyolali	1
3	Wonogiri	4
4	Karanganyar	2
5	Gunung Kidul	2

*progress May 20th, 2019



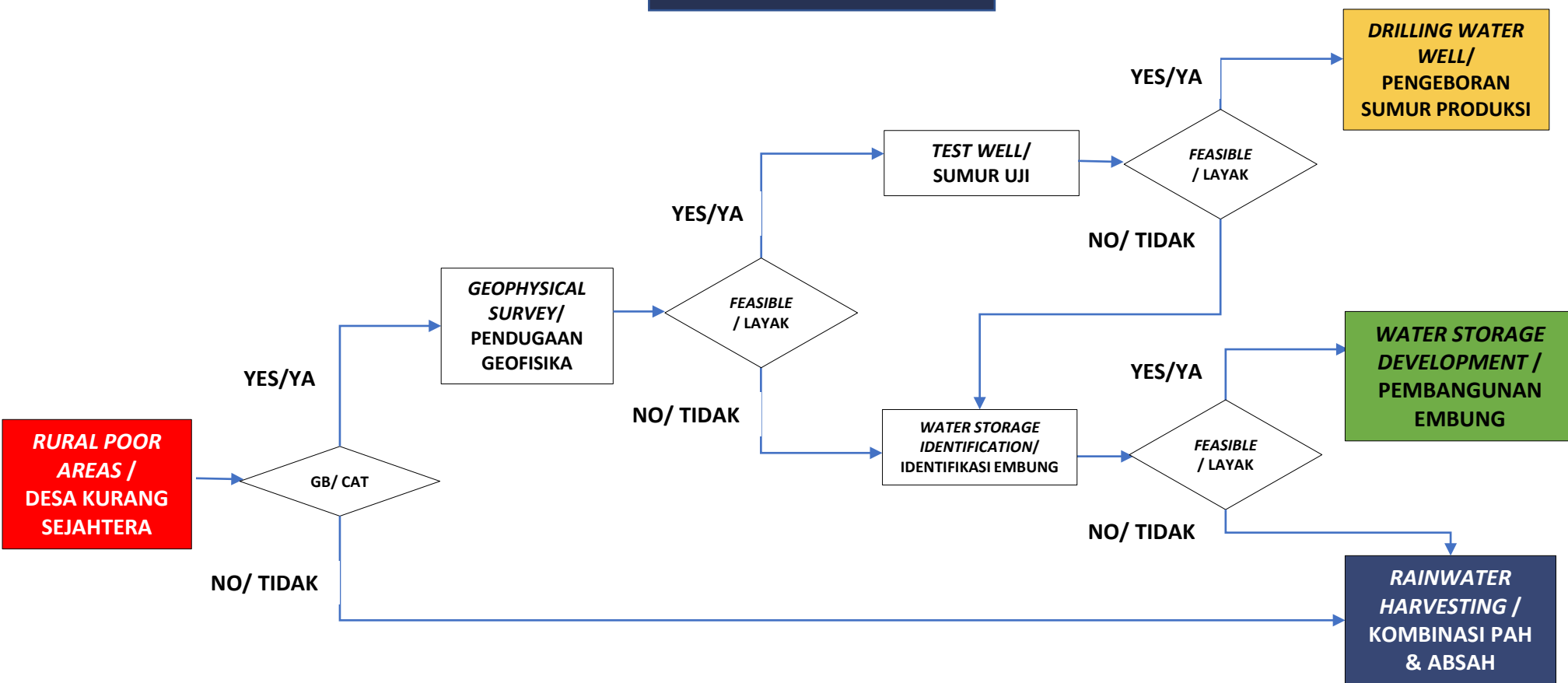
**DRINKING WATER PRODUCTION
IN BBWS BENGAWAN SOLO OFFICE**



IN-SITU STRATEGY TO PROVIDE RAW WATER FOR THE RURAL POOR AREAS

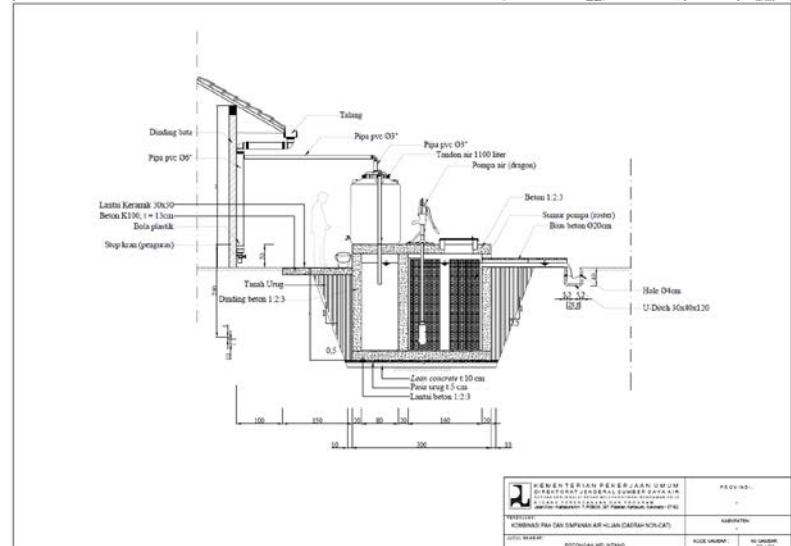
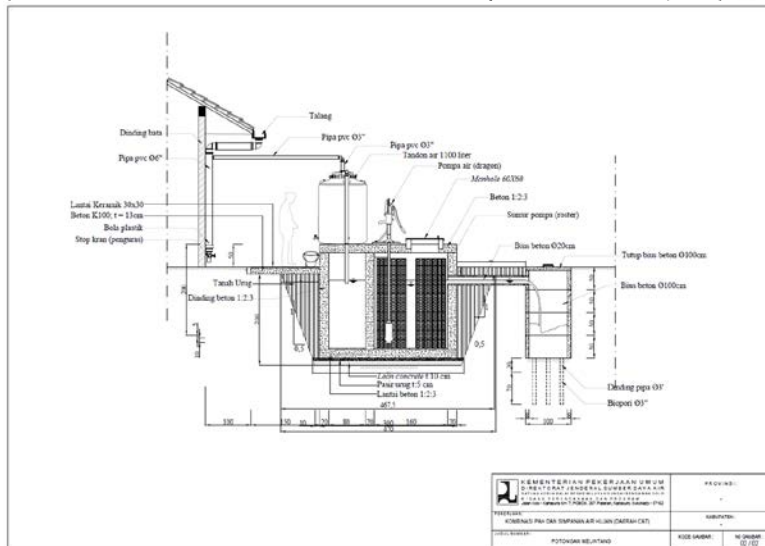
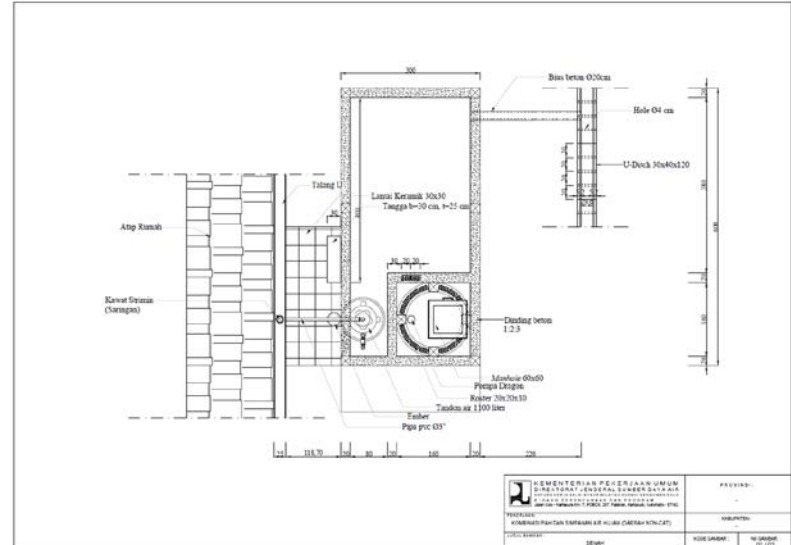
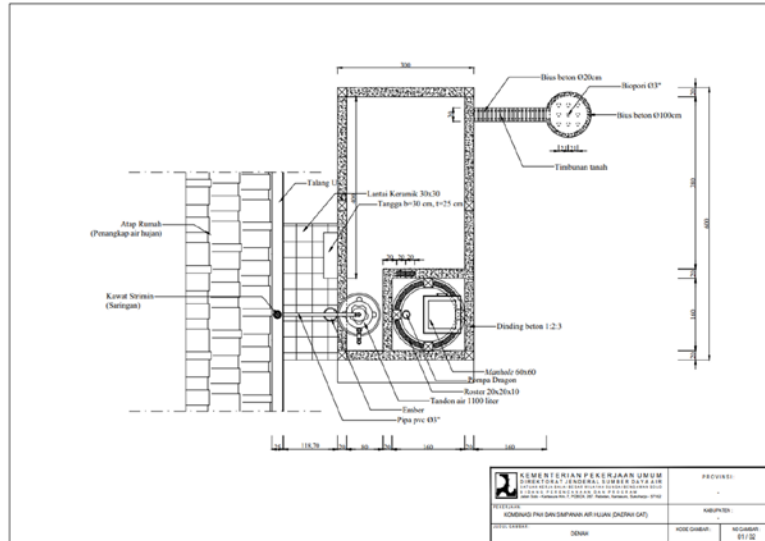
STRATEGI *IN SITU* PENYEDIAAN AIR BAKU UNTUK DESA KURANG SEJAHTERA

OFF STREAM





Combination of Rooftop Rainwater Harvesting System + Storage Tank Kombinasi PAH + ABSAH OFF STREAM



Groundwater Basin (GB) Area / Daerah CAT

Non-Groundwater Basin Area / Daerah Non CAT



04

Future Plans

Rencana Kedepan

Future Plans

Rencana Kedepan



KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
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BALAI BESAR WILAYAH SUNGAI BENGAWAN SOLO



**INFRASTRUCTURE
DEVELOPMENT /**

Pengembangan Infrastruktur

**Based on Bengawan Solo River
Basin Strategic & Master Plan
(Berdasarkan Pola & Rencana)**



COORDINATION / Koordinasi



**FLOOD MAPPING ONLINE
APPLICATION**



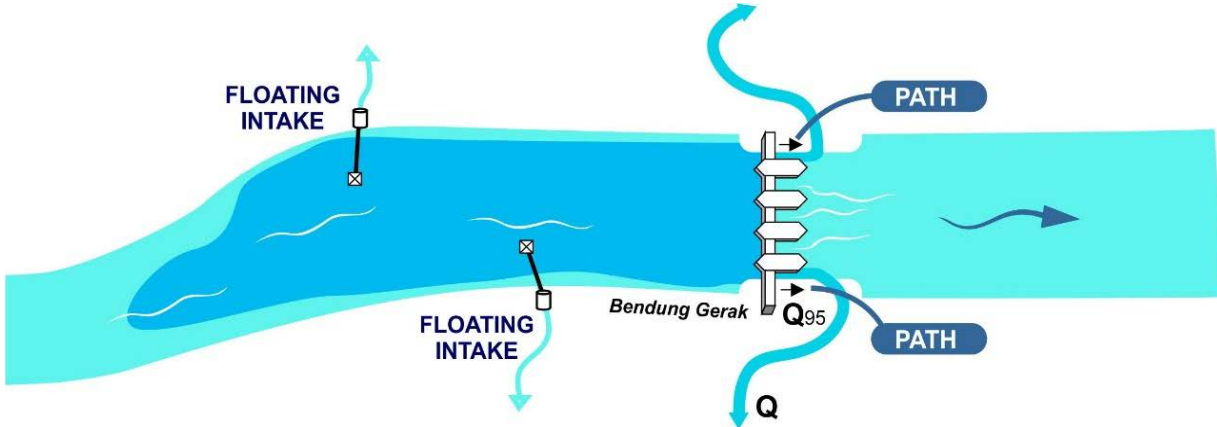
PUBLIC ANNOUNCEMENT (ONLINE)

EVACUATION ROUTES INFORMATION



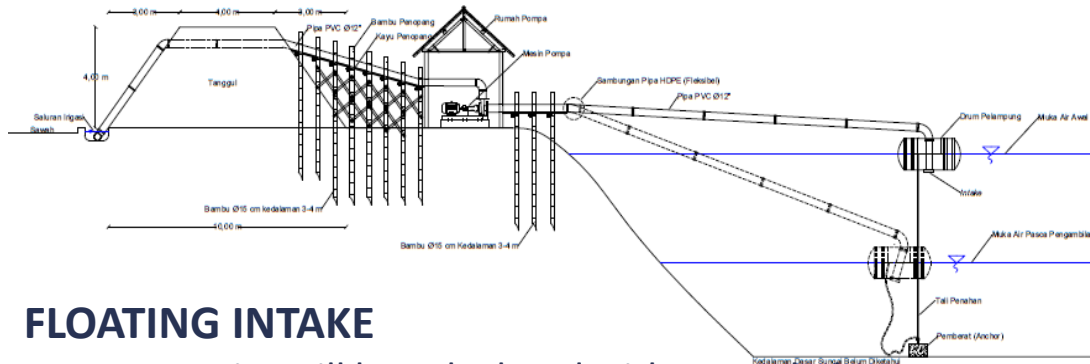
Evaluation of 3 Barrages to cope with hydro-topographic drought

Evaluasi 3 Bendung Gerak untuk mengatasi Kekeringan Hidrotopografi



PATH

To secure maintenance flow, elevate water and efficiency of gate operation
Menjamin maintenance flow, menaikkan air & efisiensi operasi pintu bendung gerak



FLOATING INTAKE

Pump capacity will be calculated with water balance



1. Intake
2. Sayap kiri
3. Pintu sukar
4. Saluran pembawa dan kolam penenang
5. Tubuh ambang
6. Tangga akses dan pipa suplai
7. Salangan rumah
8. Turbin dan pompa
9. Pipa pesat
10. Outlet atas
11. Outlet bawah
12. Rumah turbin
13. Ambang dan keonghapan

Negative Consequences of Barrages / Dampak negatif bendung gerak :

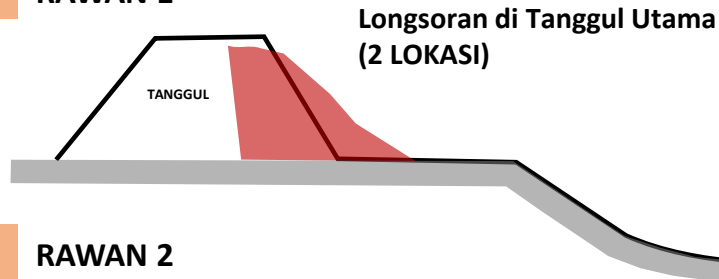
1. Unequal water distribution/ kesenjangan social terhadap air
2. Illegal water pumping / menimbulkan pemompaan liar
3. Riverbank landslides / longsor tebing sungai



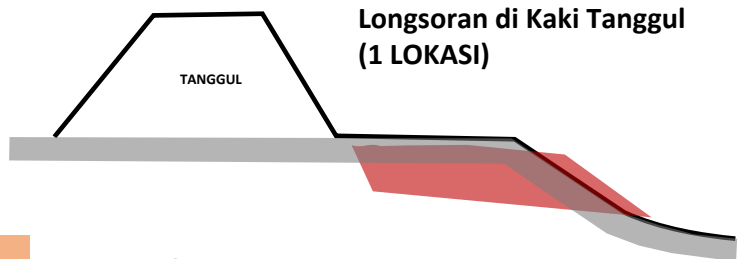
THREE CATEGORIES OF LANDSLIDES IN SOLO RIVER DOWNSTREAM

3 KATEGORI KEJADIAN LONGSOR BANTARAN DAN TANGGUL DI HILIR BENGAWAN SOLO

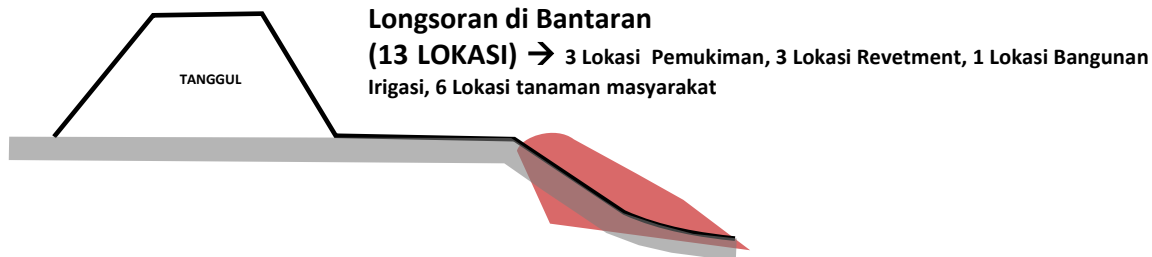
1 RAWAN 1



2 RAWAN 2



3 RAWAN 3



Oxbow Lake Utilization for Retarding Basin & Water Reserves

Pemanfaatan Oxbow Lake untuk Retarding Basin dan Cadangan Air

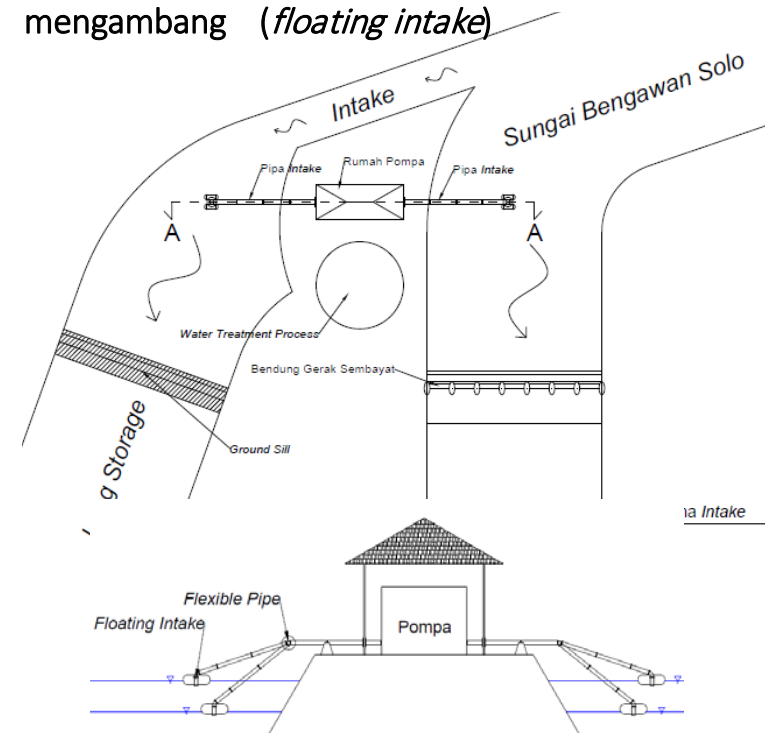


KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
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BALAI BESAR WILAYAH SUNGAI BENGAWAN SOLO

10 POTENTIAL OXBOW LAKE



- Memanfaatkan lahan bekas sungai Bengawan Solo sebagai tampungan air
- Panjang $\pm 2,64$ km, Luas $\pm 5,22$ km², Volume $\pm 15,6$ juta m³ (asumsi kedalaman 3 m)
- Pada musim hujan pengambilan dilakukan di Sungai Bengawan Solo
- Pada musim kemarau pengambilan dilakukan di longstorage bekas sungai
- Pengambilan dilakukan dengan intake mengambang (*floating intake*)

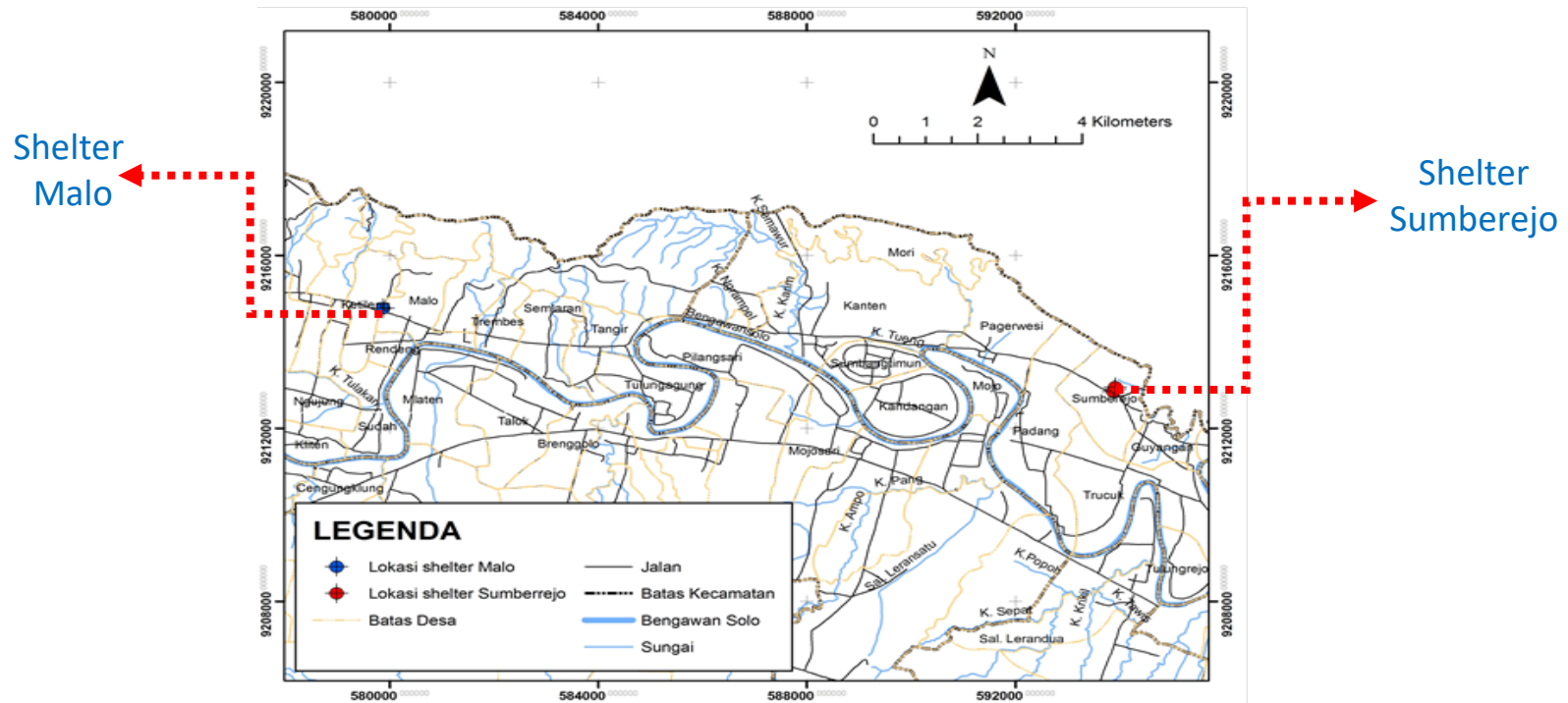


FLOOD AREA MANAGEMENT



LIVING IN HARMONY WITH FLOOD / Hidup Berdampingan dengan Banjir

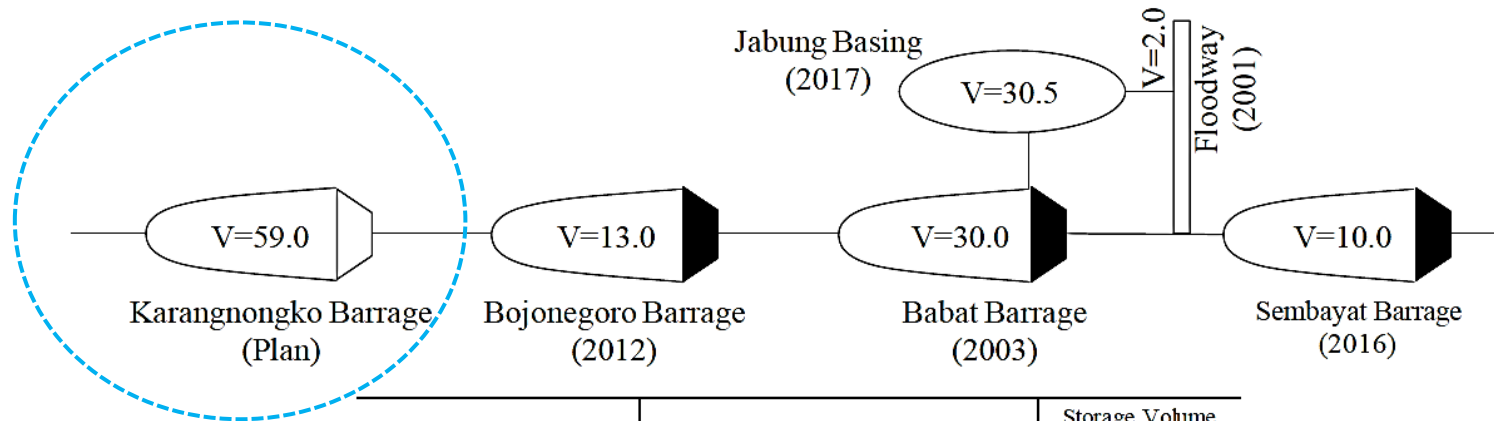
- Bojonegoro → **Flood Prone Areas / Daerah Rawan Banjir**
- 2 shelter (sumberrejo & malo), evacuation routes, aid delivery, and other facilities will be prepared / akan dibangun 2 shelter, rute evakuasi, rencana pengiriman bantuan dan fasilitas lainnya



KARANGNONGKO BARRAGE → DAM



Bendung Gerak Karangnongko menjadi Bendungan



Name of Structures	Completion Time	Storage Volume (mil. m ³)
Karangnongko Barrage	To be constructed in future (Plan)	59.0
Bojonegoro Barrage	2012	13.0
Babat Barrage	2003	(30.0)
Jabung Retarding Basin	Under construction (2017)	30.5
Floodway (Rubber Dam)	2001	2.0
Sembayat Barrage	Under construction (2016)	10.0




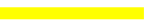




NEW CONCEPT OF SOLO VALLEY WARKEN

Konsep Baru Pengembangan Solo Valley Warken

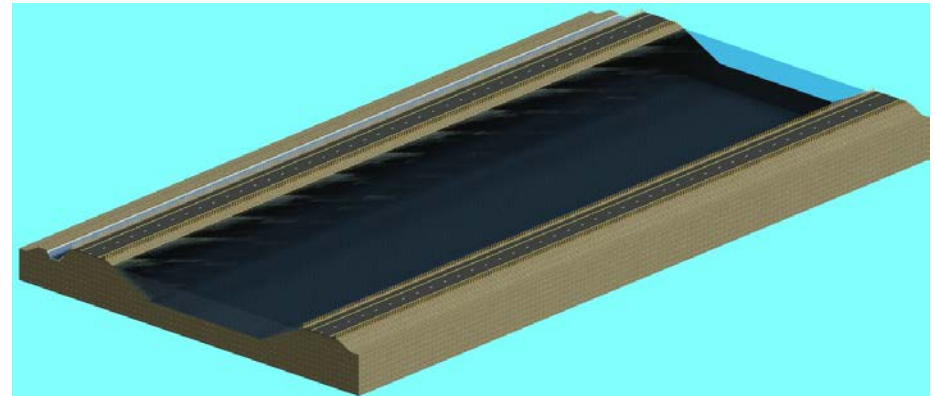
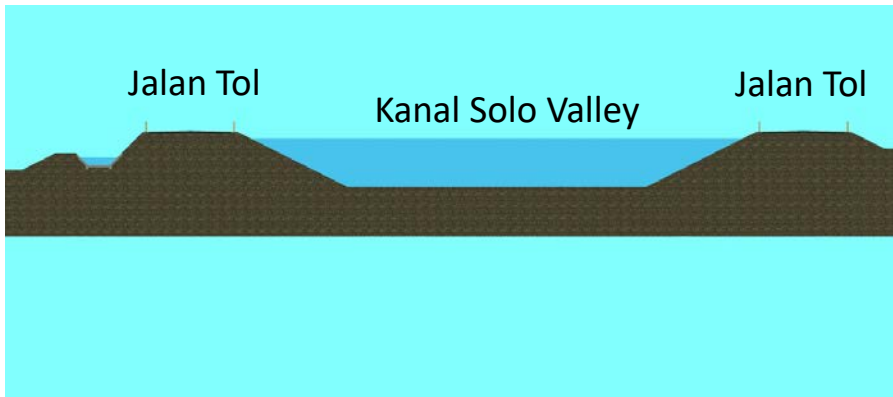
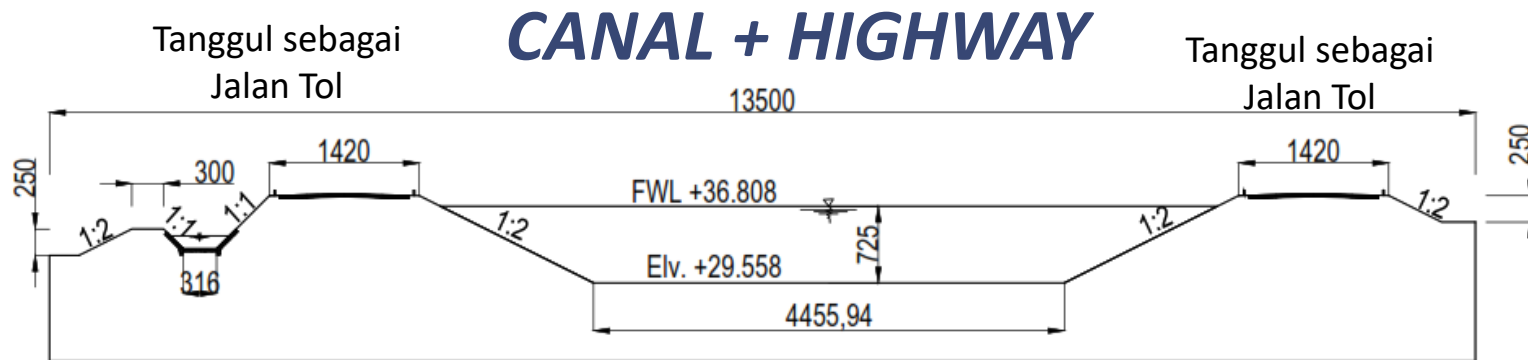


Legend / Keterangan :

-  Floodway
-  Solo Valley Werken
-  Sungai Bengawan Solo
-  Kali Lamong

NEW CONCEPT OF SOLO VALLEY WARKEN DEVELOPMENT

Konsep Baru Pengembangan Solo Valley Warken



Luas tampang kanal rencana awal = 422.625 m²

Luas tampang kanal rencana baru = 428.181 m²

INTEGRATION SOLO VALLEY WARKEN CANAL + HIGHWAY

Integrasi Kanal Solo Valley Warken dengan Jalan Tol



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Legend / Keterangan :

-  Jalan Tol Transjawa
-  Jalan Tol On Going (Semarang-Demak, KLBM)
-  Rencana Tol Gresik-Lamongan-Tuban
-  Rencana Tol Tuban-Demak
-  Rencana Kanal Longstorage dan Tol
-  Solo-Valley Ruas 1 Rencana Kanal Longstorage dan Tol
-  Solo-Valley Ruas 2



KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
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Thank You