## OUTLINE of PRESENTATION

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PUTRAJAYA DAM Background</td>
</tr>
<tr>
<td>2</td>
<td>Monitoring Program</td>
</tr>
<tr>
<td>3</td>
<td>Monitoring Results</td>
</tr>
<tr>
<td>4</td>
<td>Recommendations</td>
</tr>
</tbody>
</table>
**BACKGROUND of PUTRAJAYA DAM**

Construction Completed at: 2001  
Impoundment: 12 Jan 2002 – May 2002  
Lake area: 400 ha

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>ICOLD</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (m)</td>
<td>&gt;15</td>
<td>18-30</td>
</tr>
<tr>
<td>Dam Length (m)</td>
<td>&gt;500</td>
<td>750</td>
</tr>
<tr>
<td>Reservoir Capacity (MCM)</td>
<td>&gt;1</td>
<td>24</td>
</tr>
<tr>
<td>Max. Flood Discharge (m$^3$/s) @ spillway</td>
<td>&gt;2000</td>
<td>904</td>
</tr>
</tbody>
</table>

Thus, Putrajaya Dam is considered as a large dam by definition of *International Commission on Large Dams (ICOLD)*
COMPONENTS OF PUTRAJAYA DAM

- Reservoir
- Dam Crest
- Draw off Tower
- Dam Control Centre
- Embankment
- Labyrinth Spillway
- PICC
- Jambatan Sri Gemilang
Monitoring Programme

• Commencement of Monitoring programme : Jan 2002
• 1st Monitoring Contract June 2000 - May 2006
• 2nd Monitoring Contract June 2006 - May 2010
• Intensive Monitoring programme : 2008
• 3rd Monitoring Contract June 2010 – May 2012
• 4th Monitoring Contract June 2012 – May 2015
• 5th Monitoring Contract July 2015 – June 2018
Monitoring Program – Routine Monitoring

• Fortnightly Monitoring

• Physical Inspection

• Instrumentation Measurement for
  o 3 stations of inclinometers
  o 3 stations of extensometer
  o 24 positions of vibrating wire piezometer
  o 5 stations of standpipe piezometer
  o 3 locations of seepage chambers

• 21 positions of SSM Survey

• Spillway water level measurement

• Data Analysis and Engineer Assessment

• Monthly Reporting
Monitoring Program – Event Monitoring

- Fortnightly Monitoring
- Physical Inspection
- Instrumentation Measurement for
  - 3 stations of inclinometers
  - 3 stations of extensometer
  - 24 positions of vibrating wire piezometer
  - 5 stations of standpipe piezometer
  - 3 locations of seepage chambers
- 21 positions of SSM Survey
- Spillway water level measurement
- Data Analysis and Engineer Assessment
- Event Reporting
Monitoring Programme – Intensive Monitoring

- Fortnightly Monitoring
- Physical Inspection
- Instrumentation Measurement for
  - 3 stations of inclinometers
  - 3 stations of extensometer
  - 24 positions of vibrating wire piezometer
  - 5 stations of standpipe piezometer
  - 3 locations of seepage chambers
- 21 positions of SSM Survey
- Spillway water level measurement
– Intensive Monitoring (con’t)

• Total station and optical prism position and precise settlement monitoring
  ➢ To monitor the movement of the dam crest and precise vertical settlement direction at discrete point along the dam crest using total station and prism.

• Tracer dye test for seepage analysis
  ➢ To detect possible seepage leaked from the lake into groin area at the down stream of the dam

• Visual inspection for inclinometer tubing using infra-red micro camera
  ➢ To visually inspect the inclinometer tubing

• Finite Element Analysis on Dam Stability
• Current profiling and time travel using tracer of dye test for Putrajaya Lake
  ➢ To map the current profile of the lake

• Data Analysis and Engineer Assessment
• Intensive Monitoring Reporting
**Routine Monitoring – Physical Inspection Checklist**

Name of Dam: Putrajaya Main Dam  
Date of Monitoring:  
Type of Dam: Rock filled clay core dam  
Inspection Type: Monthly Monitoring  
Estimated Vol.: 26.5 Million m³  
Spillway Length: 292m  
Water Level: About 21.035 mRL  
Height: 30m (Dam height above stripped foundation)  
Lake Surface at RL21.0: About 650 Hectares  
Freeboard: about 2.5m (Crest at RL 23.5m)  
Weather: Sunny/Cloudy/Raining/Storm/T. Storm/__________________

<table>
<thead>
<tr>
<th>N</th>
<th>Descriptions</th>
<th>No</th>
<th>Yes</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Access Road</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Are the roads to the dam adequate to allow access by emergency or maintenance equipment and vehicle?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) General condition of lighting post. Damage or deteriorating?</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>c) Any damaged or deteriorating of the road pavement?</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>d) Any inappropriate vegetation growth?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Upstream Embankment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Any signs of instability? (Scarps, depressions, shallow slide, bulging).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Any signs of misalignment (view the waterline with respect to the alignment of the dam axis.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Any inappropriate vegetation growth?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) Are there slides, slumps or settlement were observed at upstream of the embankment?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e) Are there animal burrows or eroded gullies on the upstream of the embankment?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f) Is the upstream slope eroded from wave action?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>g) Is the rockfill embankment displaced or broken down or missing due to wave action.</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
## Physical Inspection Checklist (con’t)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>3</td>
<td><strong>Dam Crest</strong>&lt;br&gt;a) Are there cracks on the crest way?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Misalignment with reference to guardrails, post and parapet wall?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Any inappropriate vegetation growth?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) Any concrete structures damaged, deteriorating or cracks?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e) Is there any depressions, sinkholes or animal burrows?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><strong>Downstream Embankment</strong>&lt;br&gt;a) Any signs of instability? (Scarps, depressions, shallow slide, bulging).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Any signs of misalignment (view the side drain, lighting post with respect to the alignment of the dam axis.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Any inappropriate vegetation growth?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) Are there slides, slumps or settlement were observed at downstream of the embankment?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e) Are there animal burrows or eroded gullies on the downstream of the embankment?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f) Are there flowing spring or wet area at the toe of the dam?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>g) Any signs of uncontrolled seepage? Seepage water clear/ turbid?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Physical Inspection Checklist (con’t)

### 5 Spillway
- a) Any signs of instability? (concrete wall and floor displacement, separation, backfill behind walls).
- b) Does spillway channel show significant erosion, broken, or deteriorating?
- c) Any inappropriate vegetation growth on the spillway channel floor or weepholes and joints?
- d) Are spillway walls, floor or control section (spillway crest) damaged or deteriorating?

### 6 Intake Tower
- a) Any concrete cracking, differential movement, deteriorating, and surface defects?
- b) Operation of diversion gate in working order?
- c) Any inappropriate vegetation growth?
- d) Condition of glass panel and door damaged?
- e) Any misalignment, offset or differential movement of the structure and the access?
- f) Any concrete cracking, deteriorating or surface defects at the outlet structure?
- g) Any inappropriate vegetation growth at the outlet spillway?

### 7 Site Activities
- a) Does any construction activities, repairing or upgrading works on going at or surrounding or adjacent to the dam?
- b) Does this construction, repairing or upgrading works endanger the safety of the dam?
### Monitoring Instruments

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a)</strong> Inclinometer</td>
<td>- Is the Inclinometer functioning?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Is the data logger in good and working condition?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Are the inclinometer access tube for stations IN-3001, IN-3002 and IN-3003 in good condition.</td>
<td></td>
</tr>
<tr>
<td><strong>b)</strong> Extensometer Instrument</td>
<td>- Is the extensometer probe functioning?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Are the extensometer access tube for stations EX-3001, EX-3002 and EX-3003 in good condition</td>
<td></td>
</tr>
<tr>
<td><strong>c)</strong> Standpipe Piezometer</td>
<td>- Are standpipe tubes at all stations in good condition?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Is dipmeter probe sensitive with water (well functioning)?</td>
<td></td>
</tr>
<tr>
<td><strong>d)</strong> Vibrating Wire Piezometer</td>
<td>- Is the vibrating wire terminal in good condition?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Are the readings for all channels consistently readable?</td>
<td></td>
</tr>
<tr>
<td><strong>e)</strong> Seepage measurement chamber</td>
<td>- Are seepage chamber filled by silt/sediment?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Are stick gauges in good condition?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Any inappropriate vegetation growth blocking the sub-soil pipe and seepage drain?</td>
<td></td>
</tr>
</tbody>
</table>

Consultant Representative:

Name:
Routine Monitoring – Physical Inspection
## Routine Monitoring – Instruments

### Monitoring

<table>
<thead>
<tr>
<th>No</th>
<th>Instrument</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Inclinometer</strong> (IN3001–IN3003)</td>
<td>To monitor the horizontal movement of the embankment or foundation (subsurface).</td>
</tr>
<tr>
<td>2</td>
<td><strong>Magnetic probe extensometer</strong> (EX3001–EX3003)</td>
<td>To monitor the vertical displacement of the embankment &amp; the foundation of the dam (subsurface).</td>
</tr>
<tr>
<td>3</td>
<td><strong>Surface Settlement Markers</strong> (SSM1–SSM 21)</td>
<td>To measure lateral displacement &amp; settlement of the dam embankment (surface).</td>
</tr>
<tr>
<td>4</td>
<td><strong>Vibrating wire piezometer</strong> (VWP01–VWP24)</td>
<td>To monitor the pore water pressure in the clay core of the dam.</td>
</tr>
<tr>
<td>5</td>
<td><strong>Standpipe piezometer</strong> (PZ01–PZ05)</td>
<td>To monitor the piezometric levels in the stability berm downstream of the dam.</td>
</tr>
<tr>
<td>6</td>
<td><strong>Seepage measurement chamber</strong> (SC01–SC03)</td>
<td>To measure the amount of dam seepage water &amp; to monitor the flow discharge from the dam.</td>
</tr>
</tbody>
</table>
Magnetic Probe Extensometer

Layout Plan

EX-3001
EX-3002
EX-3003
Surface Settlement Markers SSM

Layout Plan
Vibrating Wire Piezometer Layout Plan

PIEZOMETER
POROUS STONE SENSING UNIT
(Enclosed)

TO PORE PRESSURE TERMINAL
OVERBURDEN
GROUT
3' MIN. BENTONITE PELLET SEAL
3' BAND

INSTALLATION DETAIL
(TYPICAL)

Water enters here; pressure is exerted on a diaphragm at the end of the sensing unit.

PIEZOMETER

PNEUMATIC TRANSDUCER
POROUS FILTER

From the piezometer, cable is connected to

Excavation Level (-7.15m RSL)

VW5
VW11
VW17
VW19

VW22 VW23

VW24

Downstream Level (146SL)

W1 about 3m RSL

CH 252

CH 402

CH 552
Standpipe Piezometer

Layout Plan

- CH100
- CH250
- CH550
- CH400
- CH650
Seepage Measurement Chamber

Coverage of SC01 (250 m)

Coverage of SC02 (170 m)

Coverage of SC03 (315 m)

SC 01

SC 02

SC 03

Layout Plan
Instantaneous Reservoir Water Level & Discharge
Emergency Response Plan (ERP)

- Documented plan that describes the actions that a water system would take in response to various major events, such as catastrophic incidents that leave extraordinary levels of mass casualties. *(United States Environmental Protection Agency)*

- 3 types of failure that may occur on a Dam
  - Seepage
  - Major Structural Failure
  - Overtopping
ERP for Seepage or Piping Failure

EMERGENCY NOTIFICATION FLOWCHART I

SEEPAGE / PIPING

Continue Monitoring

Observer/Duty Office

Reservoir Controller

Flow > 1500L/min (Flow = 25 L/s)?

Yes

Emergency Site Controller

Dam Engineer
Tel: 03-82822694

Identify Emergency Situation Monitor
Flow rate & turbidity of seepage flow

No

Continue monitoring and evaluation

Emergency Site Controller

Emergency Incident Room

Is failure of dam imminent?

Yes

Evacuate all residents in the pre-identified inundation areas

No

Are preventive and repair works effective to stop dam failure?

Yes

Execute preventive actions and repair works

Operate outlet works to lower reservoir level

No

Flow > 3000L/min with muddy water?

Continue Monitoring & maintain communication

Alert District Officers of Sepang:
03-87061211
K Langat:
03-31871963

Alert PJH
President/Chief Executive Officer Tel:

Flow rate increasing in upstream water level?

Yes

Emergency Controller

Emergency Site Communications Room

No

Inspection by Dam Assessment Team

Alert Immediate downstream and river bank dwellers

Continue monitoring and evaluation

Identify Emergency Situation Monitor
Flow rate > 1500 L/min (Flow = 25 L/s)

Flow > 1500L/min (Flow = 25 L/s)?

No

Yes

Flow rate increasing in upstream water level?

Yes

Emergency Controller

Tel:

Inspection by Dam Assessment Team

Execute preventive actions and repair works

Are preventive and repair works effective to stop dam failure?

Yes

Operate outlet works to lower reservoir level

No

Mobilize Kuala Langat District Disaster Operation Room
Tel: 03-31871963

Mobilize Sepang District Disaster Operation Room
Tel: 03-87061211

Is failure of dam imminent?

Yes

Evacuate all residents in the pre-identified inundation areas

No

Refer to Page A-6

Refer to Page A-5
EMERGENCY NOTIFICATION FLOWCHART II

MAJOR STRUCTURAL FAILURES: LANDSLIDES, EXCESSIVE MOVEMENT. EARTHQUAKE, ETC.

Observer/Duty Office

Undertake Inspection

Reservoir Controller

Emergency Site Controller
Tel: 03-8292694

Emergency Site Communications Room

Emergency Controller
Tel:

Does event affect integrity of dam & appurtenances?

No

Continue Monitoring & maintain communication

Yes

Dam Assessment Team

Executive inspection, preventive and repair works

Alert P.J.H President/Chief Executive Officer
Tel:

Emergency Incident Room

Alert District Officers of Sepang: 03-87061211
K.Langat: 03-31871963

Is Public Safety threatened?

No

Is Failure of Dam Imminent?

No

Any Preventive & Repair works effective to stop dam failure?

Mobilize Kuala Langat District Disaster Operation Room
Tel: 03-31871963

Mobilize Sepang District Disaster Operation Room
Tel: 03-87061211

Refer to Page A-6

Refer to Page A-5

Yes

Alert immediate downstream and river bank dwellers

Alert immediate downstream and river bank dwellers

Evacuate all residents in the pre-identified inundation areas

ERP for Structural Failure
**ERP for Overtopping Failure**

**Emergency Notification Flowchart III**

1. **Observer/Duty Office**
   - Record reservoir level and monitor weather conditions
   - Continue Monitoring

2. **Water Level reaches EL 23.5?**
   - Yes: Reservoir Controller
   - No: Continue Monitoring, record reservoir level and monitor weather conditions

3. **Water Level still rising and reaches EL 23.5m?**
   - Yes: Operate Draw Off Values
   - No: Continue Monitoring

4. **Emergency Site Controller**
   - Dam Engineer
   - Tel: 03-82822694

5. **Is overtopping of dam imminent?**
   - Yes: Evacuate all residents in the pre-identified inundation areas
   - No: Refer to Page A-6

**Is water level reaching EL 25.0m?**

**Alert**
- PJH President/Chief Executive Officer
  - Tel: 03-82822694
- District Officers of Sepang: 03-87061211
- K. Langat: 03-31871963

**Mobilize**
- Kuala Langat District Disaster Operation Room
  - Tel: 03-31871963
- Sepang District Disaster Operation Room
  - Tel: 03-87061211

**Operate**
- Intake Gates to lower reservoir level
- Immediate downstream and river bank dwellers
Role of Majlis Keselamatan Negara in ERP

MKN is a National body in charge of disaster management and relief in Malaysia.

• Roles of MKN included:
  • Dissemination of information pertaining to dam failure emergency events to the local agencies to react according to their own SOP
  • Disseminate warnings of imminent disaster to the public.
  • Based on the information provided by the dam authorities, establish the evacuation routes and centres.
| 01 | Preparing To Conduct A Dam Safety Inspection |
| 02 | Inspection of Embankment Dams |
| 03 | Inspection of Concrete And Masonry Dams |
| 04 | Identification of Visual Dam Safety Deficiencies |
| 05 | Inspection of Material Deficiencies |
| 06 | Inspection Of The Foundation Abutments And Reservoir Rim |
| 07 | Inspection And Testing of Gates, Valves And Other Mechanical Systems |
| 08 | Documenting And Reporting Findings From A Dam Safety Inspection |
| 09 | Evaluation of Seepage Conditions |
| 10 | Evaluation of Hydrological Adequacy |
| 11 | Instrumentation For Embankment And Concrete Dams |
| 12 | How to Develop And Implement An Emergency Action Plan |
| 13 | How to Organize An Operation And Maintenance Program |
| 14 | Procedures For Monitoring Reservoir Sedimentation |
| 15 | Downstream Hazard Classification Guidelines |
THANK YOU